The University of the State of New York

NEW YORK STATE MUSEUM

69th ANNUAL REPORT

1915

In 2 volumes

VOLUME 2

APPENDIXES 2-5

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April 23, 1917

69th ANNUAL REPORT

OF THE

NEW YORK STATE MUSEUM

VOLUME 2

To the Legislature of the State of New York

We have the honor to submit herewith, pursuant to law, as the 69th Annual Report of the New York State Museum, the report of the Director, including the reports of the State Geologist and State Paleontologist, and the reports of the State Entomologist and the State Botanist, with appendixes.

Pliny T. Sexton
Chancellor of the University
John H. Finley
President of the University and
Commissioner of Education

Appendix 2

Economic geology

Museum Bulletins 181, 190

181 The Quarry Materials of New York

190 Mining and Quarry Industry of New York 1915

New York State Museum Bulletin

Application pending for admission as second-class matter at the Post Office at Albany, N. Y. under the act of August 24, 1912

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No. 181 ALBANY, N. Y. JANUARY 1, 1916

New York State Museum

JOHN M. CLARKE, Director

THE QUARRY MATERIALS OF NEW YORK—GRANITE, GNEISS, TRAP AND MARBLE

BY

D. H. NEWLAND

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The University of the State of New York

Science Department, March 2, 1915

Dr John H. Finley

President of the University

SIR: I have the honor to transmit to you herewith and to recommend for publication as a bulletin of the State Museum, a manuscript and illustrations of a report on *The Quarry Materials of New York — Granite, Gneiss, Trap and Marble,* by David H. Newland, Assistant State Geologist.

Very respectfully

JOHN M. CLARKE

Director

Approved for publication this 15th day of March 1915

John H. Finley

President of the University

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THE QUARRY MATERIALS OF NEW YORK—GRANITE, GNEISS, TRAP AND MARBLE

BY

D. H. NEWLAND

INTRODUCTION

This report is the partial fulfilment of a plan to describe the quarry resources of the State from the present-day standpoint. It was the original purpose to include in the report a description of the sandstone and limestone quarries as well as those of the crystalline rocks. The task of collecting the information for a complete report, however, would have involved a considerable delay in the publication of the results of the first part of the investigation, which covers the crystalline areas of the Adirondacks and southeastern New York, and it was thought advisable to issue that part separately. It is the hope of the writer that a second report on the stratified rocks may be prepared within a reasonable time.

The division of the subject into two sections as outlined follows a natural line of demarcation in the geographical distribution of the formations; it likewise has a basis in scientific and economic considerations so apparent as to need no emphasis in this place.

The only description of the building stones of New York at all complete that has been available hitherto is found in the two bulletins by John C. Smock. The earlier[1] of these (1888) was of preliminary character, mainly devoted to the description of individual quarries. The second,[2] published in 1890, included most

[1] N. Y. State Mus. Bul. 3, Albany, 1888.
[2] N. Y. State Mus. Bul. 10, Albany, 1890.

of the descriptive matter of the earlier report but also contained chapters on the use of stone in cities, on the durability of stone, and the physical and chemical testing of stone; it was one of the first important quarry reports in this country to treat the subject from the scientific standpoint. The physical determinations as carried out for the report have little practical application at present, as the theory and technic of laboratory tests have been almost revolutionized in the last few years. Naturally, there have also been great changes in the economic situation of the local industry.

Reports of more restricted compass have been issued at different times. A brief account of the New York State quarry industry was given in the volumes of the Tenth Census.[1] A paper on the quarries of southeastern New York, of descriptive character, by E. C. Eckel,[2] was published in the report of the State Geologist for 1900. The limestones were described rather fully in 1901 by H. Ries,[3] and the bluestone industry by H. T. Dickinson in 1903.[4]

With few exceptions, all the quarry localities described in this bulletin have been personally visited, the field work occupying parts of the summers of 1912 and 1913. The samples obtained in the field have been used for optical, physical and chemical investigations in accordance with recent practice in the testing of quarry stones.

The writer has received valuable assistance in both the field and laboratory from R. W. Jones of the Museum staff, who is responsible for much of the chemical work undertaken for the report, and from H. Mattimore of the bureau of research, State Department of Highways, who carried out physical tests on many samples of granites. To them and also to the individual quarry operators who have extended numerous courtesies, the writer desires to express his obligations.

THE DEVELOPMENT OF THE QUARRY INDUSTRY IN NEW YORK

The extraction of stone for building and other purposes in this State has gained prominence as an industry only within relatively recent years. The use of stone in structures, however, goes back to the colonial period. As the most available of the permanent structural materials, it was employed by the early settlers in walls,

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[1] V. 10, Washington, 1884.
[2] Albany, 1902. Also printed separately.
[3] N. Y. State Mus. Bul. 44, Albany, 1901.
[4] N. Y. State Mus. Bul. 61, Albany, 1903.

foundations and occasionally for entire buildings, and there still exist good examples of such work in many of the older communities where they have stood for two centuries and more.

The stone for the early masonry was seldom quarried from solid ledges. Very little of it was cut or otherwise prepared, but it was mostly laid as rubblework. Field stones were the kind mainly used, as they were nearly everywhere abundant and the cheapest to secure, and their removal from the land was desirable from an agricultural standpoint. These stones, it may be remarked, are not indigenous to the locality of their occurrence, but with the soil in which they are found were transported from a more northerly latitude in the sweep of the Laurentian ice sheet that finally extended over the whole State. The bowlders consist of granite, gneiss, sandstone and other rocks hard enough to resist the erosion of ice and water, and of a durability tested by thousands of years exposure to the weather.

There seems no certainty as to the place or time of the first regular quarry operations. Very likely the earliest work was somewhere in the Hudson valley section, and the quarrying of limestone for the manufacture of lime suggests itself as the object of the first steady production of stone. Limestone was also required for the making of iron which was established on a permanent basis in New York State about 1751, when the Sterling furnace in Orange county was built. At the beginning of the last century the manufacture of lime had become an important industry in the Hudson River valley. About 1820 the manufacture of natural cement was started in Ulster and Onondaga counties, the basis of the industry being an impure limestone which by calcination and grinding makes a high-grade hydraulic cement. From the beginning New York State held a prominent place in the cement industry; by 1840 Ulster county alone was producing at the rate of 600,000 barrels a year, according to Mather. The output of natural cement increased to over 4,000,000 barrels a year, but about the year 1900 it began to decline owing to the cheapening of the cost of Portland cement.

The construction of the Erie canal gave an impetus to the quarrying of stone, since considerable quantities of dimension stone were used in the canal locks. It also afforded means for the conveyance of stone from the central and western parts of the State to the more thickly settled region in the east. Thus the Medina and Onondaga building stones were made available. By 1840 there had developed a considerable trade in flagstone which was obtained from the same regions as now, that is, from Ulster, Sullivan, Dela-

ware and Greene counties, and was shipped to New York and other cities along the coast. The annual product at that time is given by Mather as 3,500,000 square feet.

The stone industry of the State was first made the subject of detailed investigation in the work of the Tenth Census of 1880. The information gathered by the census included notes on the occurrence of building stone in the State and statistics of the capital investment represented in the quarries, the number of employees and production. At that time New York ranked sixth among the states in size of its quarry industry, with an output valued at $1,261,495. The industry had then reached its present stage of development so far as variety of products is concerned, but was destined to great changes in technic and to a great increase of production.

The growth of the quarry industry was particularly rapid in the decade from 1890 to 1900. This was a period of remarkable advancement in all kinds of engineering work and manufacturing, in which New York participated to its full share. The metallurgical and chemical uses of limestone showed great increase and continued to grow in the subsequent years. By the year 1900 the annual product of the State had reached a value of $4,039,102 as shown in the reports of the United States Geological Survey. This gave New York third place in the list, next after Vermont, Pennsylvania, as now, holding first rank.

In the year 1913, the latest for which statistics are available, the production was valued at $6,763,054, the valuation being placed on the materials at the quarry and not including slate or stone used in cement manufacture. The figures for the different products and kinds of stone, as returned to the State Geological Survey, are as follows:

Production of stone in New York in 1913

VARIETY	BUILDING STONE	MONUMENTAL	CURBING AND FLAGGING	CRUSHED STONE	ALL OTHER	TOTAL VALUE
Granite	$45 911	$17 013	....	$236 650	$36 068	$335 642
Limestone	101 198	....	$6 546	2 386 632	1 358 302	3 852 678
Marble	127 556	81 330	....	....	43 406	252 292
Sandstone	285 645	....	682 984	46 267	306 376	1 321 272
Trap	....	....	....	1 001 170	....	1 001 170
Total	$560 310	$98 343	$689 530	$3 670 719	$1 744 152	$6 763 054

A review of the industry for the last few years shows that progress has been rapid in some branches, while others have fairly

held their own, and that one or two branches have actually declined. The trade in bluestone within the last seven or eight years has fallen off about 50 per cent, owing to the increasing use of cement in street work. The artificial structural materials — stucco, concrete and terra cotta — also have affected adversely the market for building stone by which all quarries have been more or less affected. It is impossible of course to predict whether the present popularity of these materials will continue but it is not likely that they will make such great inroads upon the market for stone in the future as in the past. The use of cement has had one compensating feature in that it has made a large demand for crushed stone though this represents a much lower grade of product than building stone.

The quarries of limestone at present contribute more than one-half of the total value of the stone products of the State, a ratio which holds also in the country generally. It is the kind most commonly marketed for crushed stone, and is also extensively employed in metallurgy and chemical manufactures.

Section 1

GENERAL FEATURES OF ROCKS AND THEIR COMMERCIAL ADAPTABILITY

THE ORIGIN AND CLASSIFICATION OF ROCKS

Rocks may be defined in simplest terms as mineral aggregates. To this definition there may be added also the quality of solidity, an inseparable characteristic perhaps in the popular mind, though not essential from the standpoint of the geologist. These aggregates are made up of a variety of minerals, either singly or in mechanical mixture. They also differ among themselves in their structural features, in the manner in which the minerals are assembled and held together, that is, their textures, and of course according to origin.

The consideration of origin is the most important for the classification of rocks in the first instance. On that basis they may all be divided into two general groups: (1) the igneous rocks, which include all that have consolidated from a molten state and (2) the sedimentary rocks, inclusive of all that have been deposited by water, either in a state of suspension (mechanical action) or solution (chemical action). To the latter may be added also the small class of wind-laid or eolian deposits which are closely allied with the mechanical sediments in their structure and features of occurrence.

To these groups which embrace all rocks from the standpoint of origin, it is customary to add a third group of coordinate rank in the classification, or (3) the metamorphic rocks. This group includes those members of either igneous or sedimentary derivation that have undergone great changes which involve a physical rearrangement and also at times a chemical transformation of the components with the development of a new set of minerals.

There is naturally no sharp line of division between the metamorphic and the other groups; on the other hand, the process of change may be followed in many cases through all the stages from the one to the other, as from an unaltered sediment like clay through shale and slate to hard and thoroughly crystallized schist or gneiss. It is the general practice, however, to place only the more completely changed types in the metamorphic class, and especially those whose origin may not readily be discovered.

The igneous and metamorphic rocks are distinguished from the sedimentary by their crystalline character, the minerals of both having crystallized within the mass. The two are closely associated in areal distribution and together make up the oldest land surfaces now exposed to view. The great Adirondack highland consists entirely of their representatives, all antedating the earliest of the sedimentary rocks that lie upon its border and that in fact have been derived from the disintegration and erosion of the crystallines.

The structure and appearance of the different groups are conditioned by the agencies which have operated in their formation. These features can be best explained, therefore, in the light of the physical and chemical processes now effective within the earth and that have been in force probably since primitive geological times. The general scientific conception of the earth is that of a cooling body, with the interior in a highly heated state; sufficiently hot to produce instant fusion on release of the load of overlying rocks. If the earth was once thoroughly molten, as is postulated by most geologists, then the cooling process must have led to the formation of an igneous crust in the first instance. This primitive crust, through the attack of waters which settled upon it and the decomposing effects of the gases of the atmosphere, afforded the source of the earliest sediments, which were deposited in the depressed portions occupied by the seas. There are no known representatives at present of these earliest igneous and sedimentary formations.

The conditions of cooling, however, must produce a continuous source of strain within the earth in the effort of the outer portion to adjust itself to the still shrinking interior. The periodic release of this strain is evidenced in the production of faults and folds within the crust, affording the relief of pressure necessary for the liquefaction of the potentially molten rock in the interior and its migration toward the surface. Igneous activity, consequently, has not died out, but is still manifest in volcanoes and may be in progress in the hidden depths through the slow movement of large bodies that never reach the surface.

It is also believed that crustal adjustments take place in consequence of the shifting of load upon the the superstructure through the work of rivers. The large rivers bear immense amounts of detritus to be deposited in the seas hundreds and even thousands of miles from the sources. The continental interiors are being worn down and the coastal plains built up in this way. The change of

load, it is thought, is compensated by a transfer of material in the substratum in the opposite direction, which causes a sinking of the overweighted part and a corresponding elevation of the lighter areas.

The adjustments, however occasioned, are accompanied by important results in regard to rocks. Near the surface these yield to the strain by fracture, which may take the form of innumerable division planes or joints that break up the masses into polygonal blocks. Or again, there may be formed one or more great fractures along which the rocks have undergone appreciable differential movement with the production of crushed zones. These movements, if sudden, are accompanied by earthquakes. The large fractures may extend downwards for indefinite distances, affording ready channels for the passage of igneous material toward the surface, and thus are connected with volcanic action. They are frequently found with a filling of some igneous rock like trap or porphyry, marking the site of former eruptions.

Within the depths of the earth a point may be reached where the rocks can not accommodate themselves by fracture under the stress of cubical compression, but adjust themselves by plastic yielding or flowage. The weight of the overlying load causes them to have a certain mobility, although actually in a solid state. Under unequal stress as developed by side thrusts, they tend to move by flowage toward the direction of least pressure. The depth at which this method of deformation becomes effective has been estimated by calculation and experiment at from 6 to 12 miles, the latter being perhaps the maximum for the very hard resistant rocks. The influence of this mechanical action is augmented by the heat incident to the depth at which it takes place and no doubt also by occluded waters and gasses which facilitate the solution and recrystallization of the minerals.

The characteristics that are thus produced in rocks by compression within the earth's interior are quite different from those originally inherent in either igneous or sedimentary types and belong to the metamorphic class. Members of the latter, like most igneous rocks, possess a crystalline development, each mineral having crystallized acording to its definite habit, but there are differences in the arrangement of the minerals which is quite typical. Instead of a uniform distribution that arises from the cooling of an igneous magma, producing a homogeneous aspect, whatever plane may be exposed to view, they show a parallel structure and

Plate I

Photo by G. van Ingen

Joint structure in horizontal sediments, Ausable Chasm. The course of the main vertical joints is followed by the river.

their appearance varies with the direction of the surface with respect to the structure. This parallelism is brought about by the linear arrangement of certain constituents like mica or hornblende which have tabular or elongated forms; or it may be produced by the separation of unlike minerals in layers. There is some analogy between such structure and that of stratification in the sediments. But it is no criterion as to the origin of the rock for it is quite prevalent among those of igneous derivation. This structure is commonly called foliation or schistosity. It denotes usually weakened cohesion between the minerals; and rocks split more evenly along the foliation than in other directions.

The changes accomplished by metamorphism are not limited ordinarily to a physical rearrangement of the constituents. In many instances there results also a breaking up of the mineral compounds and their crystallization in new forms, more stable under the conditions. The degree to which the chemical alteration may be carried depends upon the nature of the rock and the agencies at work upon it. An igneous rock like granite under the same influences is more resistant to chemical changes than a sediment like shale. In fact, granite undergoes little alteration beyond the crushing down of the quartz and feldspar crystals and possibly a certain amount of recrystallization, producing a parallel appearance. The basic igneous rocks (those with low percentages of silica) in which the iron, magnesia and lime compounds are well represented, are more prone to chemical change; they form readily such rocks as amphibolite, serpentine and various schists. Among sediments, the limestones are recrystallized into marbles, but in the presence of silica and other compounds existing as original impurities or later introduced, they may be converted into garnetiferous, tremolitic or micaceous schists or amphibolites. Sandstones are hardened by secondary growth of the quartz grains or by deposition of silica cement so as to form quartzites. Shales are converted into slates, with microscopic mica and feldspar crystals; or by further metamorphism into schists and gneisses. Inasmuch as the agencies of metamorphism are mainly restricted to the deeper zones within the earth, the rocks which bear widespread evidence of their effects must at some time in their history have been buried far below the surface. It is only through removal of many thousands of feet of overlying rock by erosion that they are now exposed to view. They are found, therefore, among the older geological formations and include the very earliest members of which we have knowledge.

ROCK STRUCTURES

The physical features associated with the field occurrence of rocks may be considered under the head of structures. Such features include joints, faults and folds, to name some of the more important.

Joints. One of the most evident characters, common to all rocks whatever their origin, is due to the divisional planes that intersect the bodies so that they are never continuous solids, but are broken up into small blocks. These divisional planes or joints may be but a few inches apart, or they may occur at intervals of 50 or 100 feet. In fact, there is every variation almost in their frequency and in their direction with respect to each other. Very commonly there are three sets of joints which intersect at high angles, producing nearly rectangular prisms; this form is quite characteristic of the sedimentary and of the coarser-grained igneous rocks; but no absolute rule can be laid down for their occurrence. Their attitude with respect to the surface contours and their spacing are important points to be considered in the location of quarry sites, especially if the stone is to be used in dimension or monumental work.

Joints are in part primary characteristics, that is, they have been produced in the natural course of consolidation of rocks, and in part arise from stresses externally applied after the rocks were consolidated. The former kind is illustrated by the prismatic or columnar jointing found in exposures of fine-grained igneous rocks such as have cooled in narrow channels or near the surface. Fine examples are to be seen in the Palisades diabase. Such jointing is the result of strains set up in the process of cooling and proceeds always at right angles to the exposed surface.

In the sedimentary rocks, the bedding is a plane of weakened cohesion among the mineral particles and thus marks a direction of potential jointing which probably may result in actual separation on exposure of the beds to drying. The sedimentary rocks also exhibit joints that intersect the bedding at right angles, and in some cases they may be referred to the same cause, contraction on evaporation of the contained water.

It is generally considered, however, that joints are mostly secondary fractures resulting from externally applied stresses. Compression arising from crustal readjustments, or torsional and vibratory strains incident thereto, is given the greatest importance in recent contributions to the subject of jointing. The application of a single stress may be resolved into two components at right angles to each other and forming an angle of 45° with the direction of the

Plate 2

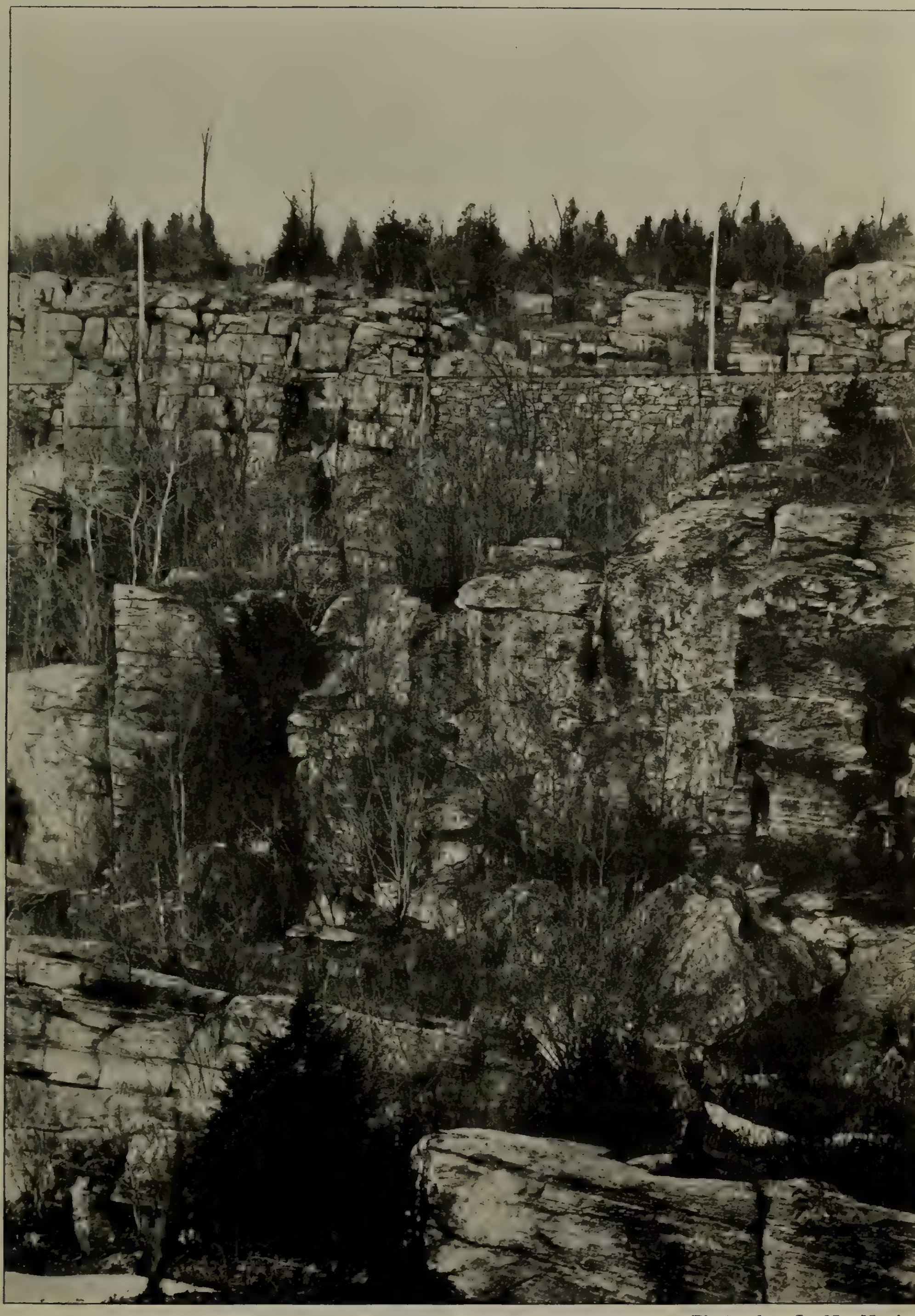

Photo by J. N. Nevins

Joint structure, Little Falls syenite. Vertical and horizontal joints in an igneous rock.

stress. Thus two joint systems arise from a single force and even more complex fractures may result, as has been demonstrated by Becker.[1]

In most rock exposures there are at least two systems of vertical or highly inclined planes nearly at right angles, and one that lies approximately horizontal, or in the sedimentary and metamorphic rocks, follows the bedding or schistosity.

The joints in one direction may be more clearly marked and persistent than in other directions. They can be divided into principal joints and minor joints. The latter often originate and die out in a short distance, but the major joints are likely to continue over wide areas. Within the crystallines of the Adirondacks, the most persistent joints have a northerly to northeasterly trend with a complementary set at right angles.

A series of closely spaced vertical joints is known to quarrymen as a heading. The zone of broken rock is used as a back or heading to work against. In such close jointing, there is often evidence of more or less faulting in the smoothed and striated surfaces and the formation of secondary minerals. A weathered appearance is also characteristic of such zones, as they serve as channels for the admission of surface waters.

The igneous rocks, especially those like granite that occur in bosses and knobs, show at times a series of close-set fractures, horizontal or slightly curved in conformity with the surface, that divide the mass into parallel plates. This is known as sheet structure and is common in many of the New England and southern granites, but appears to be rare in the Adirondacks, at least in its more typical form, although some quarries show incipient or imperfectly developed sheets. The origin of this structure has received much attention from geologists, with the proposal of various explanations. Since the fractures follow the surface contours in most cases and gradually diminish in their frequency and strength with depth, there seems to be good reason for connecting them with some superficial process like the strains set up by temperature variations. The subject is well discussed in Dale's reports on the quarries of the New England States.[2]

Faults. The phenomena incident to displacements of the rocks along fractures are quite common in the crystalline areas, and also

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[1] Proceed. Washington Acad. Sci., v. 7, July 1905, p. 267–75.

[2] For example, "The Chief Commercial Granites of Massachusetts, New Hampshire and Rhode Island." U. S. Geol. Sur. Bul. 354, 1908, p. 22–29.

in the older stratified formations. They result from strains in the outer zone of fracture and thus are connected with the formation of secondary joints. As already noted, a system of very marked jointing is often accompanied by differential motion of the rocks involved, which is denoted by their polished surfaces. When the displacement is considerable, the rocks along the fracture are much broken and sometimes mashed into a mineral pulp in which much alteration has taken place.

Fig. 1 Simple faults. *a* illustrates the common or normal fault, and *b* the reversed fault

Faulting is most common and of the greatest magnitude in the Adirondack area of which the whole eastern and southeastern boundaries between the upraised and folded crystallines and the horizontal Paleozoic sediments are defined by a series of faults. Like the massive joint systems of that section, they have a northeasterly to northerly trend; their downthrow is toward the east. Some of the interior Adirondack valleys are undoubtedly the result of faulting, either of single or compound type, but in this case, the evidences of actual displacement are not so apparent since it is confined to the crystallines alone. Valleys with abrupt slopes on both sides may be due to the sinking of the block between two faults, as is thought to be the origin of the Lake George basin. There is need of caution, however, in ascribing the existence of scarps and deep valleys in this region to faulting, as the normal course of weathering and particularly the wear of glacial ice would tend to produce sharp contours along the main joint systems.

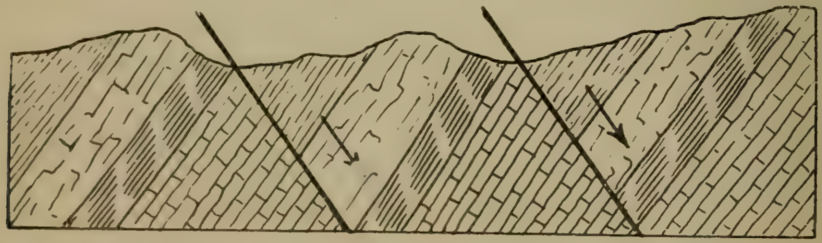

Fig. 2 Normal faulting in inclined strata; the same beds outcrop repeatedly when traced across the strike

Plate 3

Photo by S. R. Stoddard

Great fault fissure on Avalanche lake, Adirondacks

For present purposes, it is not necessary to enter upon a discussion of the various types of faults and their effects upon rock structure. They are generally to be avoided in the laying out of quarries. If the aim is to produce crushed stone, their presence may not be objectionable, but even helpful; though care must be used lest the rock be decomposed or so shattered by the faulting as to lose its qualities of hardness and toughness. In mining engineering they are of great importance, and they should be given due consideration also in the plans for permanent foundations and structures, as they mark the lines along which future crustal disturbances may occur.

Folds. The original arrangement of the sedimentary rocks, as determined by their deposition layer by layer upon the flat or slightly sloping sea bottom, is that of a series of parallel and nearly horizontal sheets. Upraisal into land may take place so gradually and uniformly as to preserve this attitude almost unchanged. Thus the great belts of limestones, shales and sandstones which occupy practically all the State south of the Mohawk and west of the Hudson, show almost no relative disturbance throughout their extent, although they have been elevated through a range of 2000 feet or more. When some of the formations are traced eastward from the Hudson toward the New England border, they rapidly lose the appearance of horizontality and assume inclined positions so as to present their upturned eroded edges to the surface. The new arrangement reflects the influence of lateral compression in bending and folding the strata so as to bring them into smaller compass.

The development of folds or flexures can be traced in the rocks through all stages from simple to very intricate forms. Every case of folding, however, may be reduced to a variation of two simple basic types, that of the uparched or saddle fold and the inverted type or downfold. The former, called an anticline, is recognized in the field, where the arch itself is concealed or eroded away, by the inclinations of the same beds in opposite directions from the central line or axis. The second type, called the syncline, has inward sloping sides which meet to form a trough.[1]

Simple open folds may have symmetrical limbs which are inclined at the same angles. This is rather exceptional and the sides more

[1] The attitude of folds in the field is found by taking observations of the inclinations and direction of the beds referred to the horizontal plane. The angle of greatest inclination to that plane is the *dip*; and the direction of outcrop with reference to the true north is the *strike*.

often show different inclinations. The close, compressed folds have straight sides which dip in nearly the same direction. The arches in such cases are often overturned so that one side rests upon the

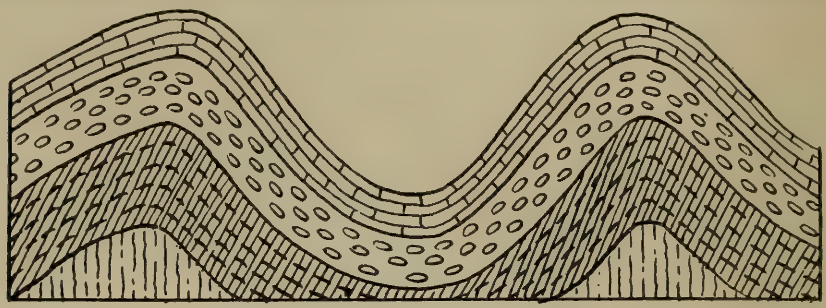

Fig. 3 Folded strata, showing a syncline bounded by two anticlines or saddles

other. Examples of the open types of folding are found in the strata that lie on the borders of our mountain areas and are occasionally seen in the limestones and sandstones of the Mohawk and central Hudson valleys. In the interior of the mountains, the folds become compressed or overturned and develop minor flexures, superimposed on the larger ones so as to produce a very complicated structure.

Folding of the intense kind is accompanied by metamorphism. The metamorphic rocks like marble, slate and schist are invariably highly folded. So intricate is the result of this folding upon the crystalline rocks of the Adirondacks, followed as it has been by profound erosion, that the nature of the flexures are only rarely determinable, though the high angles of dip and their conformity for considerable distances indicate strongly compressed strata.

The crystalline limestones and marbles, owing to their uniformity and the readiness with which they yield to stress by plastic movement, often effectually conceal the existence of folds. When seams of slightly different character or stringers of foreign materials are present, these will generally be found to be bent into a succession of winds and inverted folds that exemplify in limited compass the actual contortion that has taken place on a large scale.

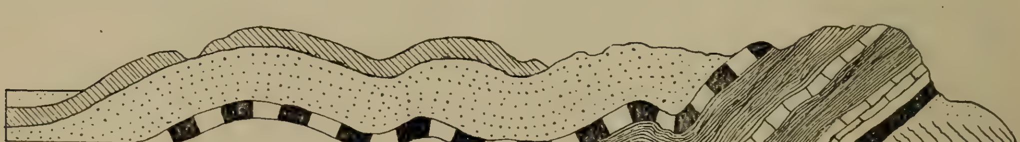

Fig. 4 Folding of the Paleozoic strata in the vicinity of Kingston, N. Y. After N. H. Darton

Great masses of igneous rock, like the areas of granite, syenite, and anorthosite in the Adirondacks, undergo much less shortening

from compression when once they have consolidated. The very early gneisses of probably igneous derivation have a lenticular or belt-like form with the large axis parallel to the general structural trend and have thus been influenced to some extent, though they were perhaps squeezed out somewhat while still molten. In general, the igneous masses serve as a buttress, against which the thrusts that fold the sedimentaries have little effect.

DIFFERENTIAL PARTING

Many rocks as found in the field show a capacity for splitting along one or more planes. This feature, when well developed, is of great advantage to the quarryman and stone dresser and upon its existence depends in great measure the availability of stone for many commercial uses. There is naturally marked variation in the behavior of rocks in regard to parting, not only between the different classes — igneous, sedimentary and metamorphic — but also among members of the same class, so that each occurrence must be separately tested for this structure.

In the sedimentary class, the direction of easiest parting coincides usually with the bedding. In the finer mechanical sediments like bluestone and shale that have been sorted and deposited by water, the structure is often exhibited in great perfection. In this case, it may be traced to the presence of platy and elongated particles among the constituents, or else to a regular alternation of finer and coarser materials parallel with the bedding planes. The chemical precipitates, which are mainly represented by limestones, show it much less frequently, being often incapable of smooth fracture, although subdivided by natural seams or joints. For that reason limestones are often stronger and more resistant to wear than the other sediments, and are specially adapted for crushed stone in road-making and concrete.

The best example of this parting among sedimentary rocks is found perhaps in the flagstones which are mostly made of fine-grained sandstones that in New York are abundant in the Devonic formations. They are locally known as bluestone, though that term is not always expressive of their appearance. Between the bedding planes of the sandstones occur closed seams which are indicated by a slight change of grain and are spoken of by the quarrymen as "reeds." According to Dickinson,[1] reeding quarries are found generally in the fine-grained stone and each locality or

[1] Quarries of Bluestone and Other Sandstones. N. Y. State Mus. Bul. 61, p. 7–8, 1903.

quarry has its own characteristic reeds. Berkey[1] states from observation of the bluestone in the Catskills that the capacity for splitting into slabs depends upon the abundance, arrangement and size of the elongated and fibrous grains. The reeds are marked by a darker color and finer grain than the body of the rock. The structure is partly original and partly arises from changes subsequent to the formation of the bluestone, whereby the fibrous appearance has been accentuated.

The massive igneous rocks, of course, are devoid of any capacity for cleavage comparable to that in bedded types. But none the less, they oftentimes possess a differential parting which greatly facilitates their manipulation in the quarry. Quite commonly the parting takes place in two directions at right angles to each other. The line along which the stone yields most readily is known as the rift; it may lie in any plane, but is more often, perhaps, nearly vertical. The direction of the second easiest cleavage is called the " grain " or sometimes the " run." Though many quarry stones seem to possess only the two lines of smooth fracture, there is occasionally a third, along which they may be broken with some degree of ease and which is known as the " head." This is less easily detected than the others, because it approaches the normal fracture of the stone.

Rift and grain are frequently described in works on the quarry industries with special reference to the granites. From the information given, the impression might be gained that these structures are only characteristic of the granites, though such conclusion is by no means warranted. The syenitic rocks of the Adirondacks often show a fairly good cleavage in two directions. Other examples of rift which may be compared with the same structure in granites are to be found in the crushed but massive-appearing anorthosites, such as those quarried in the northern Adirondacks, near Ausable Forks and Keeseville. This rock is almost entirely made up of lime-feldspar (labradorite) though some phases contain quite a little pyroxene and garnet. It splits readily in two directions so as to be easily dressed into dimension stone or paving blocks. The igneous rocks of the gabbro class, in which large percentages of pyroxene or amphibole are present, seem to lack the structure in anything like the typical development of the more acid rocks.

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[1] Quality of the Bluestone in the Vicinity of Ashokan Dam. School of Mines Quarterly, v. 29, no. 2, p. 156–57.

The cause of rift in the igneous rocks has been variously explained. Some writers have attributed it to a slight foliation produced by parallel arrangement of the mica minerals. In such cases, it is comparable to the foliation cleavage of the metamorphic

Fig. 5 Microscopic fractures in anorthosite, parallel to the rift or direction of easiest cleavage. The section is nearly pure feldspar, the small grains being garnet. Enlarged 25 times

rocks. Another cause may be found in the regular arrangement of the feldspars so as to bring their cleavages into alignment, as has been described for a Norwegian syenite. Perhaps the more common type of rift, specially in the granites, is that produced by the presence of microscopic fracture lines. Tarr, Whittle and others have noted many examples in which the cleavage arises from very minute hairlike fractures, individually somewhat irregular and discontinuous, but in general holding their direction unchanged throughout the rock mass. Such fractures are found in both quartz and feldspar. Dale[1] more recently has shown that rift may be related to minute cavities in the quartz, the cavities being arranged in parallel sheets which, in some instances, are accompanied by parallel fractures.

Among the metamorphic rocks, a foliated or gneissoid structure is usually accompanied by cleavage along the planes of foliation.

[1] U. S. Geol. Survey Bul. 354, p. 42–47, 1908.

The appearance of foliation is due to the parallel arrangement of the prismatic and scaly minerals or to the elongation of the quartz and feldspar, accompanied by more or less segregation of the constituents in alternating bands. Some rocks evidence the effects of metamorphism by granulation and recrystallization, without the development of any marked foliation. This is true of the light-colored feldspar-quartz gneisses and of the purer feldspar anorthosites that are common in the Adirondacks. These rocks, when crushed, present a massive appearance and have a smooth fracture in two or more directions, instead of a single cleavage, like the typical gneisses.

CHEMICAL AND PHYSICAL PROPERTIES OF ROCKS WHICH INFLUENCE THEIR COMMERCIAL USES

Chemical composition. The determination of chemical composition may afford much information as to the availability of rocks for different purposes. Its service in many cases, however, may be said to be rather of negative value, as determining the presence or absence of certain harmful constituents and as a test for the relative decomposition which a rock has undergone under surface weathering. The analysis is of most value when used in connection with the results of microscopic study.

Limestones are employed in large quantities by chemical and metallurgical establishments, and here an analysis is the first consideration. For some uses a magnesian limestone may be preferred; for others a high calcium variety is wanted; but nearly always the demand requires a limestone with low percentage of impurities in the form of silica, alumina and iron. For Portland cement manufacture the presence of the first two ingredients is rather an advantage, as they take the place of so much clay or shale. For building or engineering work, the analysis plays little part in deciding upon a suitable stone.

With sandstones the chemical analysis is useful mainly as a guide to the character of the cementing substance, since the sand grains themselves are chiefly quartz. Feldspathic sandstones, which are indicated by the presence of alumina, lime and alkalies, are less durable than the pure quartz kinds, but ordinarily good enough for most construction work. In the case of the igneous rocks, chemical composition has some practical significance, though its place can be supplied often by a careful study of the constituent minerals as usually carried out with thin sections under the microscope.

The percentage of silica determines whether the rock is to be classed with the acid (over 65 per cent SiO_2), intermediate (55–65 per cent), or basic (below 55 per cent) groups. In the first group free quartz, which is the most resistant of all minerals to alteration and one of the strongest, is present in quantity. All granites belong to that group. The intermediate group consists mainly of syenites and diorites in which potash and lime-soda feldspars are the main ingredients. These show a higher resistance to physical disintegration than granite, but they are perhaps a little more open to chemical alteration. In this group may be classed also the anorthosites which are made up of lime feldspar and subordinate pyroxene and which are usually classed with the gabbros in the basic division For all practical purposes they can be considered as equivalent to the syenites. The basic group is represented by the gabbros, pyroxenites, hornblendites and diabases among the more common rocks. They have high percentages of the basic or lime feldspar and of the iron-magnesian minerals, especially pyroxene and hornblende and frequently olivine. They are exceedingly tough, unyielding rocks when fresh and eminently suited for crushed stone, but are too somber in color for most construction purposes. They weather rather rapidly through chemical decomposition with the production of hydrated silicates and oxides, such as serpentine, talc and limonite.

The metamorphic rocks are chemically allied to the igneous or sedimentary types from which they have been derived.

The presence of sulphides in any building or ornamental stone is undesirable. They are indicated chemically by the percentage of sulphur dioxide in the analysis. Pyrite and marcasite, the common sulphides in rocks, break down readily in the atmosphere to iron oxides which cause unsightly stains upon the surface, though not ordinarily weakening the structure of the rock itself.

The percentages of carbon dioxide and water in igneous rocks afford valuable criteria as to their relative freshness. Carbon dioxide indicates the presence of calcite which results from the decomposition of feldspar and some of the other silicate minerals. Water in amount above a small percentage is also traceable to secondary products like kaolin, talc and serpentine.

Mineral composition. According to their relative importance, the rock-forming minerals may be divided into (*a*) essential ingredients and (*b*) nonessential or accessory ingredients. The former constitutes the bulk of rock masses, commonly all but a

few per cents of the whole; and includes all those that have any considerable influence upon the physical properties and fitness of the materials for economic uses. There are a few exceptions to be made with reference especially to the iron oxides and iron sulphides which occur in small amounts, but yet are important, the former as coloring agents and the latter owing to their tendency to decompose in the atmosphere and cause unsightly stains.

The various representatives of the igneous rocks are combinations of a small number of essential minerals. A list of the more important minerals includes quartz, feldspar, mica, amphibole, pyroxene and olivine. If to these be added nephelite, sodalite and leucite, which occur in certain areally restricted but not altogether rare types, the list of essential ingredients for the igneous class is complete.

It may be noted that all the minerals named contain silica. Quartz is silica alone, while the others are compounds known as silicates in which silica functions as an acid and combines with some of the basic elements like sodium, potassium, magnesium, calcium, iron and aluminum, to name the more common ones. Several of the minerals, namely, feldspar, mica, pyroxene and amphibole, are not single species, but mineral groups with a number of individual species possessing similar but not identical chemical and mineralogical properties.

The strength and durability of the igneous rocks in ordinary service are conditioned by the nature of the constituent minerals and the manner in which they occur. The harder and more durable ingredients are quartz and feldspar, consequently the rocks that are made up of them in larger part are the most serviceable under equal conditions. Quartz is not subject to chemical decomposition, but feldspar yields slightly to atmospheric agencies and in the course of time may become softened so as to crumble under pressure. The iron-bearing silicates which are represented by mica, amphibole, pyroxene and olivine are also subject to change under the weather, with the result that the iron is partly discharged from combination as limonite, and new combinations of silica characterized by the presence of water in considerable amount are formed. Chlorite, serpentine and talc are common secondary minerals resulting from their alteration. It may be noted that while such changes have taken place in nature on a great scale, the element of time has been a factor for which no equivalent can be found within the limits of human experience. As a matter of fact, almost any

mineral combination among the igneous rocks, provided the ingredients are not already in weathered condition, is durable enough to serve the purpose of ordinary building construction. There is little choice, so far as mineral composition is concerned, to be made between a granite, a syenite or a gabbro. From the standpoints of toughness and resistance to abrasion, which are important qualities for concrete and road materials, the syenites and the more basic rocks are likely to prove superior to the granite.

The sedimentary rocks may be classified by their mineral content into (*a*) arenaceous materials represented by sandstones and conglomerates, (*b*) argillaceous materials or clays and shales, and (*c*) calcareous materials or limestones. They have a simpler mineral composition than the igneous types. Sandstones are composed of granular quartz held together by some cementing substance. This may be a secondary deposit of quartz, in which case the rock is called quartzite; or one of the iron minerals, like limonite or hematite. The argillaceous members consist of very finely divided clayey substances with more or less quartz, calcite, iron ores, etc. They are too soft for constructional stone, but under metamorphism yield slates, schists and gneisses. The limestones consist of the mineral calcite alone, or calcite admixed with dolomite, in the latter case being called magnesian or dolomitic limestones.

Between the groups of limestones and sandstones as a whole, there is no comparison possible with regard to durable qualities. If the nature of the respective components (calcite and quartz) alone were to be considered, sandstone would be far superior, but there are other factors entering into the question. The size of the constituent particles, the porosity, and the character of the cementing substance, if any, need to be taken into account.

With sandstones, the character of the cementing substance is more important than any other feature. Some contain very little cement, being held together by the surface adhesion of the particles when brought into close contact. These are apt to be friable and little resistant to physical disintegration. Calcite is a common cement, but rather inferior, since it seems to lose its attachment to the quartz with weathering, and the rock becomes a sugary aggregate. Iron oxide in the form of hematite forms a durable binder and provides an attractive color.

The highest grade sandstones in respect to hardness, toughness and permanency are those in which the grains are bound together by quartz. Such types are called quartzites and are exemplified by

many occurrences of the Potsdam sandstone in this State. When the secondary quartz is united with the grains to build them out into interlocking crystals, as sometimes happens, the material is the most durable of all constructional stones.

Limestones are made up mainly of the calcareous skeletons of organisms, though often so finely comminuted as to be unrecognizable to the unaided eye. There is also more or less of secondary calcite, derived by solution and redeposition of the lime, which serves to fill up the interstices and the interiors of the organic remains. The calcite shows crystalline character, but is not so uniformly developed in rhombic particles as in the case of marbles. Besides calcite, the double carbonate of lime and magnesia, or dolomite, may be present in similar form. Through its increasing participation, the magnesia may replace the lime up to 20 per cent or so.

Though calcite is quite soluble in rain water and groundwaters which contain carbon dioxide, limestones, when compact and well cemented, are sufficiently durable in the mass to withstand all ordinary conditions of exposure. The purer varieties are the best. The presence of argillaceous and siliceous impurities tends to weaken their structure, as there is not the same bond between particles of different nature as exists between the uniform calcareous grains.

The metamorphic rocks require no special mention. In their mineralogy, they are related to the one or the other of these classes. Metamorphism ordinarily produces small changes in the igneous rocks so far as their mineral ingredients are concerned. With the sediments it tends toward recrystallization of the ingredients, thus making them more compact or harder than the originals, with an approach, in the case of the siliceous sediments, to the structures and mineral contents of the igneous class.

Texture. There is no doubt that texture (by which is meant the size, form and spacing of the mineral particles) plays an important rôle in the strength and durability of rocks. The relationship, however, is not always so distinct or easily grasped as might be inferred from the treatment given in some works on quarry materials. As a rule, each quarry presents features that require individual study, not alone by themselves, but with reference to the geological history and mineral content of the material.

The size of grain obviously affects the appearance and physical qualities of rocks. It is not (contrary to the opinions frequently expressed) an index of their porosity or resistance to weathering

influences. Tests show that a fine-grained granite may be as porous as a coarse-grained one, which is also true of a sandstone. There is usually a difference in the size of the pores, which are larger but less numerous in the coarser stones; consequently, it may be said that these will usually absorb moisture more readily and on the other hand dry out more quickly than similar rocks composed of particles in a fine state of division. Whether they weather more or less rapidly than their fine-grained equivalents, depends upon other factors such as the state of aggregation and relative spacing of the particles and the character of the climate.

Experiments with the St Lawrence and Jefferson county granites indicate that the coarser grades, which contain feldspars up to an inch in diameter, are as closely textured as the fine sorts. There is also no appreciable difference in the two kinds with regard to weathering, so far as can be estimated from the condition of the rocks in natural exposures.

Crystalline rocks which have consolidated at depths show little porosity, and the variations between different examples are often too slight to have significance for practical purposes. Any marked departure from the average is traceable to external influences in the way of chemical or mechanical disintegration and should be an occasion for careful investigation.

The fragmental rocks like sandstone and grits are apt to have more pore space. But a degree of porosity above the average is indicative of imperfect cementation. It denotes, therefore, perviousness to moisture, as well as inferior strength through lack of bond. Limestones and marbles may be quite as impervious as the igneous rocks. Porosity in their case may arise from solution by the seepage of underground waters, forming cavities which weaken their structure and not infrequently contain secondary deposits of iron sulphides.

Apart from these considerations, the size of grain seems to bear some relation to the strength of certain rocks. This has been noted by Julien,[1] who instances the minutely crystalline limestones as examples which may show surprising resistance to crushing; in a limestone from Lake Champlain the ultimate strength reached 25,000 pounds to the square inch. The explanation for the superior strength of such rocks, as given by that writer, is that the molecular cohesion between the grains, under equal conditions, is proportion-

[1] Building Stones — Elements of Strength in their Constitution and Structure. Journal of the Franklin Institute, v. 147. April 1899.

ate to their fineness. The apparent exceptions to this relation of grain to strength are numerous, but they are possibly accounted for by variations of interlockment and cementation between the particles.

An important element in the strength of some rocks is contributed by the interlockment of the particles, an arrangement which acts upon the general structure like hair in a mortar. This is exemplified best of all by the diabases in which the feldspar in lathlike crystals is embedded in a matrix of pyroxene, olivine and magnetite, so as to exert the utmost resistance to both tension and compression. A similar effect may be produced by prismatic hornblende and pyroxene crystals in the syenites and gabbros or by the mica scales in granites. A dovetailing of the mineral particles contributes to the strength of some marbles and granites. The grains have irregular or indented outlines instead of smooth, rounded borders and are molded upon each other in the closest form of interlockment.

A uniformity of texture with the minerals spaced after a regular pattern is an advantage both from the standpoints of appearance and of weathering qualities. It is essential for rocks that are to be subjected to abrasion and wear.

Color. Little significance attaches to color as a guide to the intrinsic merits of building stone. Within narrow limits it may indicate something in regard to the relative state of weathering but a change of color such as may be brought about by oxidation of iron or bleaching of carbon compounds on exposure to the air does not necessarily mean a deterioration in strength. From commercial considerations, however, color ranks among the very important qualities and has much to do with the favor which a stone wins in the market. This is especially true of architectural stone for use in our larger cities. There is a certain prevailing taste apparent in the selection of stone with reference to color which finds illustration in city architecture of different periods. At present, the taste seems to incline toward the very lightest colors, white or light gray, often to the exclusion of shades which are much better adapted for service in the surroundings. The employment of white marbles and very light granites for structures in manufacturing districts or for railroad stations seems inappropriate as it is unnecessary.

The colors found in rocks are too varied to be individually discussed or explained. It may be said that the principal coloring agents are iron and carbon, the former for the igneous class and

the two together in sedimentary rocks. Iron occurs in chemical combination chiefly in the silicate minerals like biotite, hornblende, augite and olivine, lending various shades of green or a black color to these ingredients of the crystalline rocks. It also occurs in the form of free oxides, sulphides and carbonate distributed through the body of the rock. The yellow, brown and reddish tints are mainly due to the oxides of iron, blue and gray to the carbonate. Carbon occurs in finely divided particles which lend a black or bluish color to certain limestones, marbles and slates.

The presence of iron in a condition of incomplete oxidation, as ferrous oxide or carbonate, or as a sulphide, is detrimental to building or ornamental stones. The original colors incident to their presence will not prove permanent. In some classes of material, the change which takes place by oxidation of these compounds produces a desirable mellowing effect, as in the Hudson River sandstones, but ordinarily it leads to red or yellow blotches. The colors resulting from the oxidation of pyrite and marcasite are also apt to run, forming streaks which extend outward from the particles and are quite frequently seen in exposed walls. Some measure of the permanancy of color in building materials may be had by a chemical analysis giving the percentages of unoxidized iron. Allowance should be made for the nature of the compound, for the mineral magnetite which contains both ferrous and ferric iron is more stable under atmospheric weathering than a ferrous compound like the carbonate. In fact magnetite is extremely resistant to change and its occurrence can not be held as a drawback to the use of any stone.

Besides the change of color that takes place in building stones through the relatively slow alteration of the components as noted, there are well-known instances where changes occur almost immediately on removal of the stone from the quarry. The nature of this change is not fully understood, but it seems to be connected in some cases with the loss of the quarry moisture or sap. As a local example may be cited some of the occurrences of the Adirondack green syenite which have a lively light to dark green color on fresh surfaces but which change within a few days to a yellow or muddy green. The change is unaccompanied by any discernible effect with respect to the mineral ingredients, and, though it seems to be connected with the loss of moisture, the original tint can not be restored by long-continued immersion in water.

The appearance of stone in a building can not be summed up entirely under color. Some kinds have a bright, clean look which

others of similar color lack. There is a strong contrast in that respect between Gouverneur marble, for example, and a noncrystalline granular limestone. The nature of the surface exposed to view also must be taken into account; in the darker stones, a marked difference usually exists between the rock face and the hammered surfaces, the latter being much lighter. The appearance of a stone in a small sample may fail to give the actual effect when seen at some distance in the walls of a building.

The granites and related silicate rocks ordinarily change very little, even on long exposure to the weather. Their coloration is lent by the inherent colors of the various minerals, rather than by the presence of some accidental ingredient diffused through the mass. In consequence of their usually complex mineral composition, they appear mottled or speckled on close view and only assume uniform tints when viewed from a distance. The coarser the texture, the greater is the distance required to produce blending. Among the ingredients of igneous rocks, quartz exercises little part in the coloration, itself being colorless or at most grayish or whitish. Feldspar is the mineral to which the granites, syenites and anorthosites owe their characteristic colors. In the granites, it is mainly white, cream or light pink, but is sometimes deep red. Its effect is toned down by the darker minerals, so that the brilliant white or red becomes gray or dark red in the body of the rock. The feldspar in syenite may be pink or gray, but is not infrequently blue or green. The feldspar (labradorite) of anorthosite has a dark green to almost black color in fresh condition, but shows nearly white when crushed and subjected to slight alteration. In the diorites, gabbros and diabases, the dark silicates, like biotite, amphibole and pyroxene, share importance with the feldspar and consequently these rocks possess rather somber tones.

Strength. The resistance which rocks offer to stress when applied to their surface varies much with the class and type. It depends upon many different factors which are mainly related to the mineral composition and texture, but which are also influenced by external conditions. Some of the relations between the physical characters of rocks, particularly textures, and strength have already been mentioned.

The igneous rocks as a class are distinguished from the other rocks by the fact that their strength is uniform, irrespective of the direction in which the stress may be applied. This depends, of course, upon their homogeneous composition and texture. In the sedimentary and metamorphic classes, the planes of bedding or

schistosity mark a weakened cohesion between the constituents which may lead to a very considerable variation in their strength, according as the latter is tested parallel with or normal to those planes. Variations of strength do occur in the igneous rocks, notably such as possess rift and grain structures, but to a minor degree as compared with the other classes.

Mineral composition affects the strength of rocks, though in general it is less important than the features connected with texture. Such a weak material as serpentine shows surprising compressive and tensile strengths when the fibers of which it is composed are thoroughly interwoven. Marbles and limestones of nearly uniform composition exhibit a wide variation in tests with variations of grain and compactness of texture. On the other hand, the presence of hard resistant minerals like quartz, hornblende and pyroxene no doubt contribute to the strength of certain igneous rocks.

The resistance of the stone to stress necessarily differs with the method of application, and the behavior of a sample under compression, which is the usual method of testing strength, does not afford any valuable information as to the resistance the stone will offer to tensile or bending stresses. This fact is very well brought out by the cracking of arches and lintels under transverse strains, whereas the same forces applied in compression have little or no effect.

The strength of stone is often injured by lack of proper care in quarrying. Stone that has been blasted from the ledge by dynamite or powder can not be expected to exhibit the same strength as that quarried with the use of the drill and wedges. Even if there are no visible cracks or checks, it will be found that the blasting has worked damage to the texture by loosening the bond between the particles.

Other conditions which affect strength are the weathering and drying out of the stone after removal from the quarry. Some soft sandstones show a remarkable gain in strength when exposed to the sun's heat and the consequent evaporation of the quarry sap. When saturated again, they lose some of this acquired strength, but are still more resistant than the freshly quarried rock; exposure to a wide range of temperature is, however, detrimental to any stone.

THE EXAMINATION AND TESTING OF STONE

The availability of any stone for commercial use depends first of all upon the features connected with its field occurrence. Geological observations are necessary to determine the quantity of

material that can be readily quarried; the physical conditions affecting the course and economy of quarry work; and the general character of the stone with regard to color, texture and the larger structural variations incident to inclusions, segregations, dikes and veins. Even liberal samples collected with a great deal of care fail to convey the same information respecting the general features of the stone that is gained by an inspection of the exposure or quarry pit itself.

The next consideration is to establish the physical properties of the stone so as to be able to forecast with some certainty its relative fitness for the special service that may be demanded of it. This information is afforded by mineralogical and chemical investigations supplemented by physical tests along the line of those adopted for estimating the strength and durability of other structural materials. Furthermore, a comparative study of the behavior of different quarry stones under conditions of actual service will be helpful in applying the results obtained by laboratory experimentation. In fact, physical tests alone may lead to erroneous conclusions as to the relative value of samples, and the guidance obtainable by observations of materials of similar nature in actual service is highly essential in forming an estimate.

QUARRY OBSERVATIONS

The field relations of quarry stones may be said to comprehend practically the whole range of variations of rock occurrence. Their interpretation requires a broad knowledge of the origin and structure of rocks and the modifications produced by surface agencies which can hardly be presented here. Such knowledge is in part to be found in any standard work on geology and in part rests upon personal experience gained by study in the field. Only a few general matters will be given attention here.

The granites and related igneous rocks ordinarily occur in large bodies and are continuous for indefinite distances into the earth. The question of quantity of material is not so important, therefore, as the situation with respect to ease of quarrying. The most advantageous situation for quarry work is along the side of a hill, as it facilitates the handling of the stone and secures natural drainage. The direction and frequency of joints exert much influence upon the relative ease of obtaining blocks and also determine whether stone of size for building and monumental work can be had. A rift and grain structure is necessary if the stone is to be used for dimension work or paving blocks.

Variations in the character of the igneous rocks are produced by pegmatitic and aplitic segregations and dikes, by quartz veins, and by inclusions of foreign materials that have been involved in the mass during its progress toward the surface. These are detrimental to uniformity of the product, or may necessitate the discarding of much material in the quarry work. They are not so important in case the stone is to be used for engineering work in which appearance is a minor consideration.

With the sedimentary rocks, the dip or inclination of the beds is a matter of importance. With ordinary quarry materials exploitation under cover is impracticable on account of the cost, though it may be adopted in the case of marble or slate. The thickness and succession of the beds, the presence of shale partings, variations of texture and color, and the spacing of the joints are features to be noted. When the beds lie nearly flat and their edges are not exposed in nearby stream valleys, it may be necessary to prospect the beds by test holes. For that purpose, a diamond or shot drill is used and the cost of securing cores by such method may be expected to amount to several dollars a foot; ordinarily, only shallow holes are necessary, but the expense is proportionately large on account of frequency of moving and setting up the drill.

The sedimentary rocks, unless broken and faulted by dynamic agencies, may be expected to extend over wide areas. It is not safe, however, to rely on the continuity of individual layers for any considerable distance without evidence in the matter. In the clastic rocks like sandstones, especially, the character of the beds may change quite rapidly, or the layers may wedge out to be succeeded by others of different color or texture. This feature is well illustrated by the Medina sandstones which are subject to rapid variations along the strike, the heavy and valuable beds becoming thin or shaly within short distances, though on the dip they are apparently more persistent. The use of the core drill will often effect a large saving in the development work of quarry properties.

The value of observations in the field as to the durability or weathering qualities of stone is not of much consequence. At most, they can be used only to compare the relative resistance of different materials when exposed to similar conditions. That the conditions depend much upon the topography and the character of the soil covering appears very evident and the variations in these respects may overbalance the factors inherent in the stones themselves. Thus the evidences of weathering are more apparent in valley bottoms where the process of decomposition and disintegration is

cumulative in its effects than upon a hill where the products are removed nearly as rapidly as they are formed. In a glaciated country like this State, the presence or absence of bowlder clay is an important feature in determining the effects of weathering. When that material rests directly upon rock, the latter is always much fresher in appearance than when covered with sand or soil.

It is now quite generally conceded that no reliable estimate can be made from the weathering qualities of rock in place as to its probable permanency when placed in the walls of a building. That conclusion was reached in the course of an investigation carried out a few years ago by a commission appointed by the Prussian government. The report of the commission, as quoted from Parks' *Building and Ornamental Stone of Canada,*[1] stated that:

> 1 The alterations produced in stone by the agents acting in the crust of the earth are not comparable with those caused by the action of the atmosphere on stone placed in a building.
>
> 2 Changes are produced in the course of the geological ages which can not possibly be effected in the length of time that a building stands.
>
> 3 The obtaining of a measure of the time necessary for distinct alteration to appear in a building stone and for the time required for the alteration to proceed through different stages is not assisted at all by observations on geological weathering.

MICROSCOPIC EXAMINATION

The microscope beyond all doubt is the most valuable single adjunct for the laboratory investigation of structural stone. There is no other method that at once yields so many important facts and with so little outlay of time or expenditure for equipment.

The information which may be had from the examination of rock samples with the microscope include: (1) the identity of the various mineral ingredients, from those of macroscopic size down to the finest particles: sulphides, carbonates and any other harmful components are quickly revealed; (2) the size, form, interlockment or cementation of the grains; (3) the compactness of the rock, or its relative porosity; (4) the condition of the minerals with respect to weathering; (5) the relative proportion of the different minerals. As minerals are definite chemical compounds, the determination of the relative abundance of each variety affords a measure for reckoning the quantitative chemical composition. The results are not so accurate as those obtained by actual chemical analysis, but in ex-

[1] Department of Mines, Ottawa, v. 1, p. 57. 1912.

perienced hands the method can be made to give the essential features with sufficient accuracy for all practical purposes.

The microscope used for rock examination is of special construction, differing from the ordinary instrument chiefly in the use of polarized light which is secured by two Nicol prisms, one of which is placed below the stage and the other either in the tube or above the eyepiece.

Rock samples for examination under the microscope must be reduced to such thinness that they are perfectly transparent. This means a thickness of 0.1 mm or less. The sections are prepared from chips an inch or so in diameter that are broken off from the rock sample with a small hammer, or better from flat pieces cut with the diamond saw. These are ground smooth on one surface with the aid of a lap wheel or glass plate, using emery or carborundum and water for abrasive. When a perfectly flat surface, free of scratches, is obtained, this is cemented to the object glass with Canada balsam. The other side is then ground down until the section is of the required thinness, after which the sample is cleaned and a cover glass cemented on it with balsam. The preparation is permanent and can be filed away for future reference.

To determine the proportions of the minerals in the section, from which determination the chemical composition may be reckoned with some degree of accuracy, the method adopted is that first devised by Delesse [1] and later perfected by Rosiwal.[2] This depends upon the principle that the areas occupied by the several minerals in the section bear the same relations as the respective volumes of the minerals. Delesse made a tracing of the outlines of the minerals, gave each species a separate color, and then applied the tracing to a sheet of tinfoil. The latter was divided carefully along the boundaries of the minerals and the pieces corresponding to each species were separately weighed. The result gave the proportions of the several ingredients. The Rosiwal modification consists of tracing on the cover glass a network of lines equally spaced and intersecting each other at right angles. The ratio of the total length of the lines to the sum of the intercepts of the mineral particles on the lines is approximately the ratio of the total surface to the area occupied by each mineral. The accuracy of the method, according

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[1] Delesse, M. A. Procédé mécanique pour déterminer la composition des roches. Paris, 1862.

[2] Rosiwal, August. Ueber geometrische Gesteinsanalysen, Verhandlungen der K. K. geologischen Reichsanstalt zu Wien. v. 32, p. 143–75.

to Rosiwal, is indirectly proportional to the average size of grain of the rock and directly to the length of the selected system of lines.

A further improvement of this method has been recently described by Hirschwald.[1] It consists of a microscopic eyepiece in the focus of which are placed two glass plates, one ruled with a set of ordinates and the other with abscissas, the latter plate being movable along the edge of the first by means of a screw turned with the fingers. The microscope, when focused upon the section, shows the two scales superposed upon the surface; the movable or horizontal scale is used to measure the intercepts of the mineral particles. By readjusting the movable scale, the measurement may be repeated until the area of view is covered. It is recommended by Hirschwald that the measurements be taken at such intervals as to cover the average grains by two or three readings, the number depending on the size of the particles.

The microscopic method of approximating the chemical composition is considered by Hirschwald to be preferable to chemical analysis in some instances. Such is the case with sandstones that contain decomposable ingredients and those of hard siliceous nature, and it serves equally well to determine the amount of cement.

There is need of much care in selecting the samples for microscopic examination to insure that they represent a fair average of the rock. It is also unsafe to depend on the evidence obtained from a single section. As the area of a section is usually less than a square inch, the minerals may not be present in it in the same proportion as in the rock mass, especially if the grain be coarse. Inaccurate results are often much worse than none, as illustrated by the misinformation that is often circulated by quarry owners and which sometimes originates from supposedly reliable sources.

CHEMICAL ANALYSIS

The making of a complete chemical analysis of a rock is a laborious operation that requires special equipment and much chemical knowledge and experience. It is also expensive. For ordinary practical purposes, and when the stone is not limestone or quartzite for use in metallurgy or chemical manufacture, such analysis is not required.

In the case of igneous rocks, it is quite important to determine the water, carbon dioxide and sulphur. The water and carbon

[1] Hirschwald, J. Handbuch der Bautechnischen Gesteinsprüfung, Berlin, 1912, p. 146–47, 167–72.

dioxide afford a measure of the freshness of the rock, but should be supplemented by microscopic study. The sulphur establishes the relative proportions of the sulphides — pyrite, marcasite or chalcopyrite.

The presence of carbonates in igneous rocks can be quickly determined by powdering a little of the sample and treating with very dilute hydrochloric acid or equal amounts of acetic acid and water. If carbonates are present, bubbles will form around the powder and gradually rise to the surface.

PHYSICAL TESTS

The laboratory testing of stone is an attempt to ascertain the resistance which the material will offer to the various stresses that arise in engineering and architectural structures. The practice has but recently come into favor in this country, but it has been followed abroad for a longer time. The general interest now taken in the subject may be ascribed largely to the initiative of the engineering staffs connected with highway and other public improvements.

One of the first reports on quarry materials to give attention to their physical testing and to embody a fairly comprehensive series of results is Smock's "Building Stone in New York."[1] The data of the tests relate to specific gravity, absorption, the action of acids, change of temperature and the influence of heat.

It is well to note that the capacity of a rock to resist the many variations of strain can not be estimated by any single physical test. Crushing strength alone means little as to the quality of stone for use in street work or its probable behavior when placed in an arch. Moreover, physical tests of any kind do not fill the place of microscopic investigation of the mineral association and textures of rocks and their full value is attained only when they are combined with the results of study into all the general properties of the materials.

The most comprehensive work on the subject of testing of stone undoubtedly is Hirschwald's "Handbuch der Bautechnischen Gesteinsprüfung," which has already been referred to. The work is a scientific exposition of the subject based on actual results obtained by the use of various physical, chemical and microscopic methods of investigation. The volume was issued in 1912 so that

[1] N. Y. State Museum Bul. 10. 1890.

it can be said to represent the most modern practice, with special reference, of course, to German and continental methods.

The different physical tests are designed to yield information as to the following properties: specific gravity and weight; porosity; absorption; hardness and toughness; strength under compressive, transverse, tensile and shearing stresses; wear or abrasion; resistance to fire; and durability when exposed to frost, changes of temperature and other weathering influences. These will be briefly discussed in their order.

Specific gravity and weight. The specific gravity of any material is its weight compared with an equal volume of pure water. In the case of solid bodies like rocks that are insoluble in water, the determination is carried out by weighing the samples in air and then finding their weight when suspended in distilled water. The weight in air divided by the loss of weight in water is the specific gravity. The matter, however, is not quite so simple, owing to the fact that rocks are more or less porous and there is some trouble in securing moisture-free samples for the first weighing and complete saturation of the samples for the second. This can be accomplished, however, in the following manner: samples of cubical shape, weighing at least 40 or 50 gramms, are heated in an air bath at 110° C. until they show no further loss of moisture, when they are placed in a desiccator and allowed to cool. After weighing, they are immersed in distilled water which at first may be boiled to hasten the expulsion of air. They should be maintained under water for a period of from three to four days, when they will have reached a condition of practically complete saturation. They are then removed from the bath, their outer surfaces rapidly dried with blotting paper and then weighed. It will be found that determinations made in this way are fairly accurate, and there is less opportunity for error through faulty manipulation than by determining the gravity with the use of a picnometer or specific gravity bottle. It gains a further advantage in that the same samples and weights are useful in finding the porosity.

The weight of stone per cubic foot is usually determined by multiplying the specific gravity into the weight of a cubic foot of water, which is 62.4 pounds. This is sufficiently accurate for the closely textured rocks, but with porous sandstones a deduction must be made equivalent to the weight of the same rock required to fill the pore space. A more direct method is to weigh a cubic or rec-

tangular piece of the rock of known volume after drying to constant weight. From that result, the weight per cubic foot is readily calculated.

Porosity. The determination of porosity is one of the most important physical tests. The pores of rocks admit moisture, and its expansion on freezing exerts such pressure as may lead to disruption of the material. The scaling of some sandstones when exposed to frost action is very noticeable. Furthermore, under equal conditions porosity affords some indication as to the resistance stones will offer to the solvent action of waters and vapors and to the penetration of smoke, dust and other discoloring agencies. It has been held by some writers that the porosity is an absolute measure of the durability of stone; but this is an overstatement of the matter, since the size of the pores and their relations to each other, that is, whether isolated or connected by capillary channels, has as much, if not more, influence than the absolute porosity.

The total pore space or porosity is readily calculated from the determinations for specific gravity, according to the method already described. The difference between the weights of the samples dry and saturated gives the amount of water absorbed in the pores. By multiplying this quantity by the specific gravity, we obtain an expression for the weight of rock required to fill the vacant pore space. This, added to the dry weight, gives the total weight the sample would have if there were no pore space. If the weight of rock required to fill the pores is then divided by the latter and the result multiplied by 100, we have the porosity expressed in percentage of the volume of the sample. This method devised by Buckley has been commonly followed in the reports on American building stones. It has been used in the determinations made in connection with the present report.

German testing laboratories measure the porosity somewhat differently by determining the specific gravity of the powdered rock and the so-called "Raumgewicht" or density of the stone inclusive of pores. The latter is found by dividing the weight of the sample expressed in grams by the volume in cubic centimeters. The difference of the two values divided by the specific gravity and the result multiplied by 100 gives what is called the coefficient of porosity.[1]

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[1] Consult Hirschwald, "Handbuch der bautechnischen Gesteinsprüfung," p. 109–10.

Absorption. The absorption of a rock is the ratio between the weight of the absorbed water and the dry weight of the sample. It is determinable, therefore, from the same measurements that are used in finding the porosity. The weight of the absorbed water is divided by the weight of the dry stone; the result multiplied by 100 gives absorption as a percentage of the mass. The relation between porosity and absorption varies with the specific gravity of the stone, but the latter commonly amounts to about one-half of the former.

The ratio of absorption, any more than the porosity, does not afford an absolute index of the permeability of stone to water. Parks[1] has conducted an interesting experiment to test the permeability in samples having different porosities. Samples of rock 3 mm thick were cut at right angles to the bedding planes. Through these pieces water was forced under pressure of 15 pounds to the square inch and the amount of flow in one hour recorded. It was found that stones having less than 1 per cent of pore space were practically impermeable to water under that pressure. The results on some sedimentary rocks are as follows:

STONE	POROSITY PER CENT	PERMEABILITY: CU. CM OF WATER AN HOUR
Guelph limestone	15.883	90.5
Guelph limestone	14.62	155.1
Chazy limestone	17.517	2.25
Medina sandstone	10.44	2130
Niagara limestone	10.443	12.75
Beekmantown limestone	1.313	.72
Potsdam sandstone	4.947	1.75

Hardness and toughness. Hardness is a property of homogeneous materials like minerals by which they resist penetration. It lacks the same degree of definiteness when applied to rocks which are composed of various minerals and perhaps held together by some cementing substance of still different nature. In such conditions, it may be regarded as the resultant of the hardness of the various ingredients plus the bond between them.

There is no uniformity in the practice of determining hardness, which is an important feature of materials to be used in paving and street work generally. One method follows that in use for comparing the hardness of minerals and is based on the rate of penetration

[1] "Building and Ornamental Stones of Canada, Ottawa, 1912," v. 1, p. 61–62.

of a drill. The common practice in laboratories for the testing of roadstones is to subject a specimen of definite dimensions to the abrading action of a grinding disc. The loss of weight after the disc has revolved a certain number of times is a measure of the hardness. In the laboratories of the State Department of Highways at Albany, the test is carried out on a core of rock, 1 inch in diameter and 3 to 4 inches long, obtained with a diamond drill. The ends of the core are faced off and then the latter is weighed. One end is placed against a Dorry grinding machine, so as to bear with constant pressure upon the disc upon which quartz sand of standard quality and size is fed. The disc is revolved 500 revolutions at the rate of 2000 revolutions an hour, when the core is taken out, reversed end for end, and ground for another 500 revolutions. The loss in weight in grams is noted. One-third of this loss subtracted from 20 is the relative hardness. A hardness below 14 is considered soft, between 14 and 17 medium and above 17 high.

Toughness may be defined as the resistance to rupture from impact by a falling body. It differs from hardness in that it depends mainly upon the texture of the material, more especially the manner in which the components are interlocked. Fibrous aggregates like those of talc, serpentine and gypsum, though possessing little hardness, are very resistant to rupture, as shown by the difficulty in pulverizing such materials in a ball mill. Tests for toughness are commonly carried out on roadstones, but have less value for building materials. The method of testing toughness as adopted in the New York State Department of Highways is as follows:

> The toughness test is made by taking two core pieces one inch in diameter which have been obtained with the diamond drill, as was done for the hardness test. The ends of these core pieces are accurately and carefully smoothed off so as to form cylinders 1 inch in height. They are then placed on a firm, level bearing in an impact machine, securely clamped and subjected to blows through a one-kilogram weight. The first blow of the hammer is from a height of 1 centimeter. Each succeeding blow is from a height 1 centimeter greater than the preceding one. The number of blows, which equals the drop expressed in centimeters of the last blow required to break the core, is considered as the toughness of the stone. The toughness of the stone is represented by the average of the two core pieces broken. A toughness below 13 is considered low, between 13 and 19 medium and above 19 high.

Strength. The crushing strength is determined by applying a gradually increasing pressure upon a cube placed between two steel plates until the stone breaks down. It is usual to note also the pressure at which the first crack occurs. The value of the results depends upon the care used in preparing the cubes, which should be sawed, not dressed to size with the hammer, and also upon the relation of the faces of the cube to the structure of the stone in the quarry. In sedimentary rocks, the pressure should be applied at right angles to the bedding. In granites and other igneous rocks that have rift and grain, tests should be made upon three samples of each rock, so as to find the strength perpendicular respectively to the rift, grain and heading. Even with the greatest care in the selection of samples and their preparation, the tests will show wide variations in the crushing strength of rock from the same quarry. Nearly any quarry material, however, has sufficient strength to withstand any compressive force that is likely to develop in the walls of a building. Buckley states that a stone with a crushing strength of 5000 pounds to the square inch is sufficiently strong for any ordinary building.[1]

The transverse strength is determined on rectangular pieces which are supported at the ends on knife edges and subjected to a pressure in the middle from another knife edge. The test has some value for stone to be used in arches, lintels, and similar purposes.

Tensile strength is seldom determined on stone, although commonly tested in cements. It is equally, if not more important, however, than the compressive strength, as it measures the bonding power and gives some indication as to the behavior of stones under the internal stresses of contraction and expansion. Shearing strength is measured by the resistance the stone offers to forces tending to displace the particles with reference to each other. Tests for it are rarely made.

Wear or abrasion. The resistance to wear by abrasion may be said to be dependent upon the qualities of hardness and toughness. It is useful to determine such resistance in macadam and paving stones. The method employed in the State Department of Highways is to prepare with the aid of a breaking press, cubical samples of from 1¼ to 2½ inches diameter, of which 50 will approximate 5 kilograms in weight. The pieces are then washed, dried, and placed in a cast-iron cylinder, mounted at an angle of 30° with the axis of rotation, and revolved for 10,000 revolutions at the rate

[1] Building Stones of Wisconsin, p. 59.

of 2000 times an hour. The stone is then taken out, washed, dried and the weight of material less than one-sixteenth of an inch in size computed. The per cent of loss of the original weight is expressed by the French coefficient which is obtained by dividing 40 by the per cent of wear. Thus a stone which loses 4 per cent in weight during the test would show a coefficient of wear of 10. A coefficient of wear below 8 is considered low, between 8 and 13 medium, between 13 and 20 high and over 20 very high.

Resistance to fire. The resistance of stone to intense heat may be considered one of the important qualities in building stones that should be given consideration by the architect and builder, but which is very often neglected. Fires in cities work great damage upon stone structures. The test of extreme heat followed by sudden chilling from the play of water upon the surface is one that very few stones will pass through with strength and appearance unimpaired. There is, however, considerable variation among different building stones in respect to fire resistance, as may be observed in their condition after a large conflagration like that of Baltimore or San Francisco. Some buildings are completely ruined, so far as the possibility of making any use of the stone work for reconstruction; others are only damaged as to their exposed parts like the cornices and window openings; and some appear to be practically uninjured.

Intense heat causes both physical and chemical changes in stone. The most apparent effect is the spalling and cracking incident to unequal expansion between the outer and inner parts of the blocks. Stone has a very low capacity for transmitting heat; consequently, the interior may be still comparatively cool while the surface is intensely hot. This difference in temperature sets up a stress that disrupts the stone or causes the outer part to flake off in successive layers. The same process takes place in nature where changes of temperature are extreme; in the arid regions like the Great Basin, the warmth of the sun after a cool night causes the scaling of bare rock surfaces, but of course at a comparatively slow rate.

The disruption of rocks of complex mineral composition, such as granite, is probably traceable to some extent to the loosening of the bond between the ingredients through intergranular strain. Quartz, feldspar and mica each has its own rate of expansion which must produce a certain amount of differential thrust under rapid temperature changes. Further, most granites hold occluded liquids and gases in closed cavities which were imprisoned during the consolidation of the mass from its state of liquid fusion. These are

mainly found in the quartz which is the last ingredient to separate out from an igneous magma. Under high temperature, they exert, no doubt, a heavy pressure upon the walls of the minute cavities and thus cooperate with the other influences in the work of disintegration.

From consideration of the physical characteristics, it would appear that the varieties of rock having a close, firmly interlocked fabric and simple mineral composition would prove the most resistant to fire. Among the igneous rocks, granite might naturally be expected to succumb more easily than a rock like syenite or anorthosite which is composed mainly of feldspar, and actual tests seem to bear out that inference. Some sandstones are very nearly fireproof and limestones and marbles generally bear up well until the heat is sufficient to effect crumbling through calcination. The temperature necessary to produce incipient calcination of small cubes of limestone, according to Buckley,[1] lies between 1000° and 2000° F. McCourt[2] states that tests on some New York limestones did not show calcination at 550° C. (1022° F.).

A temperature sufficient to cause flaking and cracking of granite, as well as sandstone and marble, may be attained in a fire that is confined to the contents of a single building. The State Capitol fire of March 29, 1911, which extended to only a part of the western wing of that building, played havoc with the granite columns and ornamental work, so that it was necessary to replace them wherever they came in direct contact with the flames. The columns were from Connecticut and Nova Scotia quarries. Some of the sandstone and marbles used in the interior work were cracked, but as a rule stood up better than the granite. The granite on the exterior of the building (a medium-grained gray stone from Maine) was injured to a minor extent, except in the lintels and cornices and other exposed parts, which were more or less cracked or disintegrated.

Exposure to fire may bring about more or less change of color, through oxidation of any ferrous iron compounds or the dehydration of limonite. It may also break down or expel some of the organic compounds which are coloring agents in limestones.

Tests for fire resistance are usually conducted on small samples of cubic shape, from one to four inches thick. The larger the samples, the more nearly will the results approach those produced on building materials in an actual conflagration.

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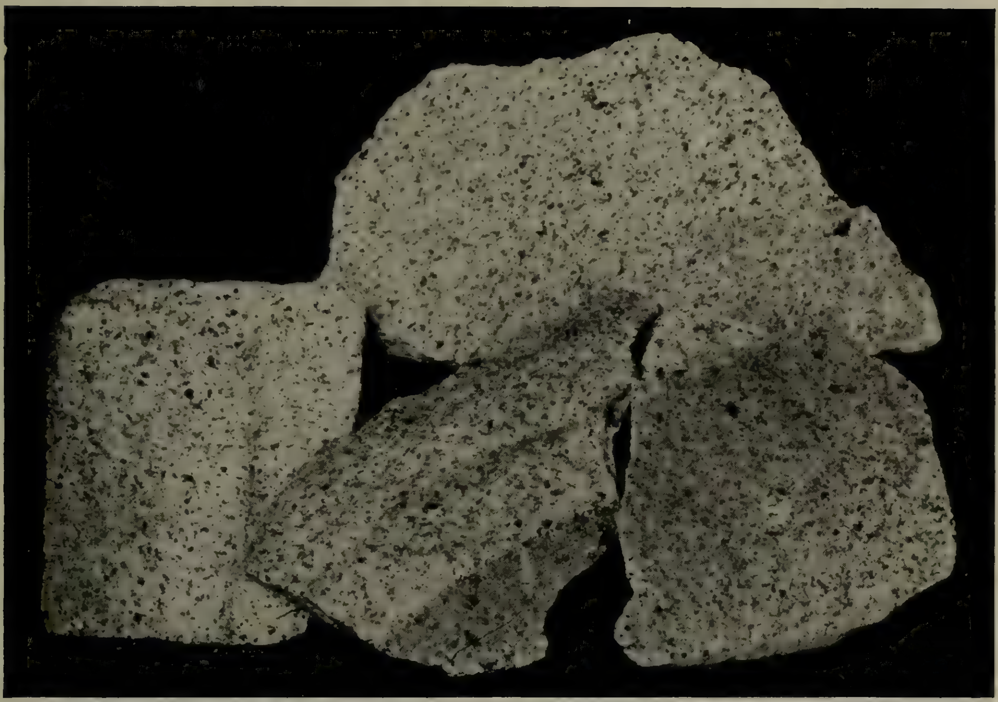
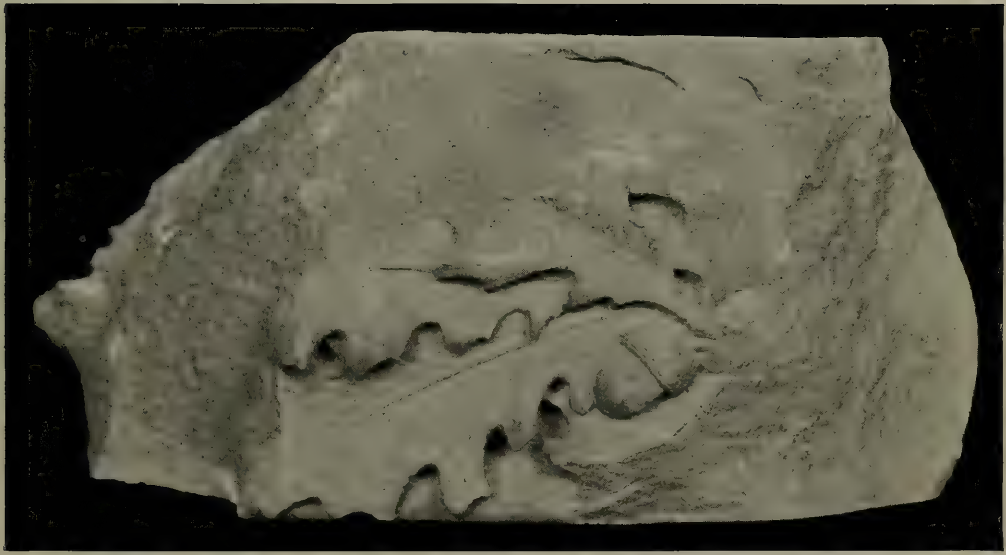
[1] *Op. cit.*, p. 385.

[2] Fire Tests on Some New York Building Stones. N. Y. State Mus. Bul. 100, p. 22. 1906.

Plate 4





Effects of fire upon building stone. Above are shown spalls of granite from a column, below a cracked and broken sandstone cap; both are from the State Capitol, Albany, after the fire of March 29, 1911.

McCourt,[1] who experimented with some of the principal building stones from local quarries, employed three-inch cubes, making, so far as the materials would allow, six tests on each sample. Four tests were performed in a Seger gas furnace in which one cube at a time was heated. The heat was applied gradually until a temperature of 550° C. was reached, this being maintained for half an hour. The cube was then taken out and allowed to cool in the air. A second sample was heated to the same temperature and then chilled suddenly by a stream of water. The third tube was treated in the same way as the first, except it was heated to 850°, and the fourth heated to 850° was chilled with water. Five tests were made with a gas blast to imitate, so far as practicable, the actual play of flame in a conflagration. On one sample, the blast operated for ten minutes, enveloping three sides in a steady stream; after cooling for five minutes, the cube again received the blast during ten minutes, after which it was cooled. The second cube was subjected to the flame for ten minutes and then a strong stream of water along with the blast for a period of five minutes. Then the water was turned off and the flame continued for another five minutes, after which, for five minutes more, the flame and water together were allowed to act on the sample. For the details for the tests, the reader should consult the paper itself. In brief, the results showed that all stones were fairly resistant to a temperature of 550° C. (1022° F.), and curiously, the granites showed up somewhat better than the others. At 850° C. (1562° F.), which probably represents the degree of heat reached in a conflagration, perhaps exceeding the temperature in some cases, all the stones were more or less injured, the amount of damage varying with the individual cubes. The granites and gneisses cracked and spalled. The sandstones parted along the bedding planes, a few developing cross-fractures. The limestones were little injured up to the point where calcination began, but after that they failed badly. The marbles developed cracks before the calcination temperature. The results, as pointed out by McCourt, were indicative of the effects of flame and water upon exposed stone work like cornices, lintels etc., rather than upon stone laid in walls which would suffer much less injury.

Action of frost. Structural stone that is exposed to the recurrent effects of freezing and thawing may suffer more or less damage therefrom in the course of time. The ability to resist this kind of weathering is to some extent measurable by porosity, since it is the

[1] *Op. cit.*

pressure exerted by the freezing of the included moisture that causes the damage. As already stated, however, neither the porosity nor the ratio of absorption can be regarded as an index of the resistance to such action under all conditions, since the character of the pore cavities exercises probably even more influence than their relative proportion.

Other things being equal, if the pores are sufficiently large and connected to permit the fairly rapid escape of the absorbed water, the stone will prove more resistant than one having an intimate network of fine or capillary pores.

The expansion of water in changing to solid ice amounts to one-tenth of its volume. It is, therefore, necessary that the pores should be filled to about nine-tenths of their capacity before the frost begins to become effective; otherwise, there will be room for the expansion to take place without exerting any pressure. In nature, the condition of saturation in stone is very rarely approached and it is difficultly attainable even with the methods employed in the laboratory for determining porosity. It is, therefore, the degree to which the pores of a stone can be filled under natural conditions that determines the resistance to frost. The experimental tests in which complete saturation is established by long-continued soaking or with the aid of a vacuum are too severe for practical use.

Hirschwald found that pieces of sandstone and granite removed from a building in Berlin at the end of December, about the beginning of freezing weather, and after a rainfall of 80 mm in the months of November and December, showed only a fraction of the moisture they were capable of absorbing. The specimens were taken from a height of 20 cm above and below the ground level. The samples of sandstone contained from one twenty-fourth to one twenty-eighth the amount of water they would hold after one hour's immersion. The granite from above ground level held about one-third and that from below the same quantity that the granite would absorb in one hour.

The quantity of water absorbed by stone under natural conditions divided by the amount the same stone requires for the entire filling of the pores is termed the saturation coefficient. The danger point is reached when the coefficient is .9, as with more than that proportion the water on freezing will expand and exert pressure upon the cavity walls. According to Hirschwald, who bases his conclusions on about twelve hundred tests of different stones, the practical limit may be taken at .8.

The method for determining frost resistance as described by that writer is to subject the samples after soaking to a temperature of — 15° C. for four hours. The sample is then thawed in water at 20° C. The operation is repeated twenty-five times after which it is examined for any weakening of strength or for fractures. The degree of saturation to which the samples are subjected at the beginning depends upon whether it is a matter of testing stones for use in dams or similar works submerged in water or for ordinary structures. In the former case, they are soaked for a period of 30 days. In testing architectural stones, they are placed in water for a period of from 2 to 13 hours, depending on their density.

In Smock's report are included the results of several tests on New York building stones. The samples weighing from 300 to 400 grams were saturated with water and subjected to alternate freezing and thawing seven times. All the granites and limestones passed the tests uninjured so far as noted; likewise the marbles, except one sample from Pleasantville; and the sandstones, with the exception of one sample from Oswego Falls. The two samples specified developed checks after repeated freezings.

Section 2

MAIN FEATURES OF THE GEOLOGY OF NEW YORK STATE

The physical features of our State as they now appear have their beginnings far back in the remote periods of geologic time. Among the rock formations underlying its surface are some of the oldest that are anywhere exposed on the American continent, possibly antedating the appearance of life, and at any rate so completely altered by the vicissitudes of the ages that they show no recognizable organic remains and few of their original physical structures. It is in those Precambric formations as represented in the Adirondacks and the southeastern Highlands that the earliest records of the physical development of our State are to be sought.

There is naturally much doubt about the conditions which prevailed in the remote periods of time included within the Precambric era. It would appear, however, that the continental land surface already existed in general outline in that era, although of course the area was not confined by the present bounds. Most of the Precambric formations now exposed are gathered in the north on the Canadian side of the boundary; the southern line of this central or nuclear area follows the St Lawrence river from the Gulf to the Great Lakes. But there are important extensions of this old land to the south of Lake Superior in Michigan, Wisconsin and Minnesota and also one considerable area farther east in the Adirondacks. The Hudson Highlands, a part of the Appalachian highland, also have Precambric strata along their main axis.

The lowest formations of this old land surface which are largely of igneous character may be separately classed in the Archean system. Upon their exposed parts the agencies of construction and destruction were operative probably in a similar manner and with equal energy as now. From the erosional waste, extensive deposits of limestone, shale and sandstone were accumulated at a later period beneath the waters which encroached on the land. These old sediments, aside from their highly metamorphosed states, are not essentially different from those accumulated during succeeding ages. Volcanic forces no doubt had their part in the development of the structure, but all vestiges of the ancient lava flows have been swept away and only the underlying channels are now in evidence with their fillings of diabase and porphyry.

In the Adirondack region no basement or crystalline complex assignable to the Archean period has been discovered. The oldest igneous rocks apparently have intrusive relations with the sediments whenever they come in contact with the latter, and consequently the first recognizable elements are of clastic origin, classed as Grenville or Algonkian. These consist of crystalline limestones or marbles, banded and foliated gneisses, hornblende and mica schists, and quartzites. They are interfolded with the early igneous gneisses and have been invaded and injected by all the Precambric intrusions. They have consequently a patchy distribution, though forming belts of rather wide extent on the northwestern side. They bear no recognizable life remains and the only evidence that life existed at the time is the abundance of carbon in the form of carbonates and graphite. The more important quarry materials of Grenville age are the limestones which yield building and monumental marbles and are sources of high-grade limes.

The deep-seated igneous rocks consist of granites (both gneissoid and massive), syenite, gabbro and anorthosite. Among the granites may be recognized at least two classes based on their relative age; an older, much compressed, finely granular variety that has been squeezed out and elongated into beltlike bodies, and a younger, massive, coarser type that occurs in the form of bathyliths and bosses. In the earlier series may be present parts of the Archean basement if they are anywhere existent. The younger granites are most useful for quarry purposes. The Adirondack syenite has sometimes a reddish color, like that of much of the granite into which it grades in places, but the characteristic and by far the most widely developed variety is a green augite syenite, usually with the original textures and structures well preserved. There are, however, crushed and more or less foliated types of the green syenite. The gabbros are found in dikes and bosses as separate intrusions and as border phases of the anorthosite with which there appears to be complete gradation. The anorthosite constitutes an immense bathylith in the east central section of the Adirondacks, the largest intrusion of the whole region and, except for a few areas of Grenville which were probably engulfed during its approach to the surface, a practically unbroken mass. The several periods of igneous activity to which these deep-seated masses may be assigned were probably times of crustal upheaval and metamorphism, at least the varied conditions of foliation, crushing and recrystallization which are exhibited by the intrusions seem to be significant of repeated modifications by dynamic agencies. As the last mani-

festation of igneous action in the Precambric era came intrusions of diabase, reaching the surface no doubt and forming lavas, but now found only in the filled-up channels or dikes below the old outlets. There are countless numbers of these dikes in the eastern and northern Adirondacks. They are all younger than the last period of general metamorphism and have remained practically unchanged, except by surface weathering.

The Highlands region, according to the more recent investigations which have been carried on chiefly by Berkey,[1] presents quite an array of Precambric rocks quite similar to those already enumerated for the Adirondacks, except that here the acid or more siliceous types greatly predominate in the igneous complex. The main element in the geology of the central area is a group of gneisses, which are known to be composite, though they have not been definitely classified. They include the oldest formations and such contrasting representatives as the massive granite gneiss of Storm King in the northern section and the foliated banded Fordham gneiss which has sedimentary affinities and is widely distributed in Westchester county. There is also a considerable development of mixed types, probably an involved aggregate of igneous and sedimentary derivatives. Small bands of crystalline limestone and quartzite are found in the central Highlands and, with the older sedimentary gneisses, constitute a series which is placed by Berkey in the Grenville. There seems to be no recognizable parts of the Archean in this section. The Precambric intrusives are mostly granites, with a few syenites and diorites. Igneous activities did not cease, however, with the close of the Precambric, as was the case in the Adirondacks, but continued as late at least as Siluric times.

The older gneisses in the region are succeeded by a group of metamorphosed sedimentary formations including crystalline limestones, schists and quartzites. These find strong representation in the southern section where the limestones have some importance for building marbles and lime-burning. While they are certainly younger than the gneisses of the central Highlands, their precise place and relations are not altogether clear. It is possible, as has been suggested by Merrill, that they are the more thoroughly metamorphosed equivalents of the Hudson river beds to the north of the Highlands, in which case they belong to the Cambric and

[1] See specially "Structure and Stratigraphic Features of the Basal Gneisses of the Highlands." N. Y. State Mus. Bul. 107, 1907.

Lower Siluric systems. Berkey would separate them into an earlier Precambric and a later or Paleozoic group, of which the Precambric group is made up of the Lowerre quartzite, Inwood limestone and Manhattan schist — the members that belong more strictly to the Highlands region. The later, or Paleozoic formations, are the Poughquag quartzite, Wappinger limestone and Hudson River slates; they occur only in small down-faulted areas in the Highlands, but have a very widespread distribution north of there, particularly the slates which outcrop along the whole central Hudson valley. The Yonkers gneiss may be mentioned in connection with the Precambric, as an igneous derivative, later than the Fordham gneiss with which it is in contact. It occurs in a long narrow belt and in isolated bodies in southern Westchester county. According to the earlier interpretation, as advanced by Merrill, its age is later than the Hudson River slates. The rock has considerable local importance as a building stone.

The period of Precambric history, so far as it can be formulated from the rocks of the New York areas, began, therefore, with the accumulation of sediments composed of quartzose, argillaceous and calcareous materials that are collectively known as the Grenville series. They must have been derived from some preexisting rocks which, if still found anywhere, represent the Archean or basal complex of the Lake Superior and Canadian regions, but so far no vestiges of this older surface have been identified. Subsequent to their deposition, there was a long lapse of time in which the forces of upheaval, metamorphism and igneous activity were manifested at intervals on a tremendous scale. The sediments were compressed, plicated and completely recrystallized. Their lower parts were invaded and broken up by deep-seated intrusions, representing several different periods and rock varieties. Volcanic energy was also displayed and led no doubt to extensive accumulations of lavas and other igneous materials at the surface. By these agencies, the land areas must have acquired a very considerable elevation, probably with a rugged mountainous topography to which the surface of the present day is hardly comparable as to altitude and massive features. Upon such land surfaces erosion would be very active and powerful in its results. Destruction thus was in progress while the upbuilding went on; while in the latter part of the Precambric time there was a long period of continued erosion without compensation by uplift. The effects of this were the removal of an immense but unknown thickness of rock from the upper zone, leaving the deeper buried parts exposed much as they

are today and greatly reducing the inequalities of contour. The waste thus derived was washed toward the sea to form the first of the normal fossiliferous rocks.

The Paleozoic era began with the deposition of sediments upon the uneven surface of the Precambric crystalline rocks. It appears that with the close of the Precambric era the land which had remained above water since Grenville time underwent a gradual subsidence, bringing the outer borders within reach of the sea. With its submergence there were formed stratified deposits which contain the earliest records of life that are at all well defined and abundant. The lowest members, belonging to the Lower and Middle Cambric groups, are not so widely developed in this State as the Upper or Saratogian group in which lies the Potsdam sandstone. This is exposed in a rather broad but variable belt on the north and northwestern sides of the Adirondacks where it still preserves a horizontal position on the eroded edges of the Precambric rocks. It is also present in the Lake Champlain valley and on the southeastern edge of the Adirondacks as broken areas of a once continuous belt. In its characteristic form it is a quartzite, and a very hard, durable stone. The lowermost Cambric beds include the Poughquag quartzite in southern Dutchess county and the Georgia slates found in the metamorphic area along the New England boundary. Besides the Potsdam quartzite, the Saratogian group also contains some limestones of which the better known member, the Little Falls dolomite, is quite extensively developed in the Mohawk valley and is the basis of quarry operations. The limestones are usually impure, representing a transition from the sandstones to the high-grade limestones above.

With the continuance of the submergence and consequent deepening of the waters, the deposition of the Champlainic or Lower Siluric beds was begun without any break or interruption to mark the line of division with the Cambric group. The more important representatives in the lower part consist of limestones, of which the Tribes Hill, and Beekmantown and Chazy members may be named. The first has little importance areally, but the Beekmantown (inclusive of the middle and upper beds as earlier defined) is quite widely distributed in the Champlain valley. The Chazy is found in the same region from Saratoga county north to the Canadian border; it is one of the purest calcium limestones in the State. The subsidence of the land surface continued and the waters encroached more and more upon it. This provided opportunity for the deposition of the Mohawkian (Trenton) group of limestones,

the most widespread and the thickest of the calcareous sediments. Among the individual members are included the Lowville, Black River and Trenton beds in the order of sequence. In the lower section they are heavily bedded and quite pure, but become shaly toward the top. They have importance for building stone, cement and lime manufacture. They are often highly fossiliferous. They occur in the Champlain valley, but are more prominent on the Vermont side than on the New York shores. Continuous with the Vermont area, a belt extends across Washington county into Warren and Saratoga counties. Another large belt begins in the Mohawk valley near Little Falls and extends northwesterly with increasing width to the St Lawrence river, overlapping onto the Adirondack crystalline rocks. The upper limestone beds of the Trenton pass gradually into shales, indicating an influx of mud. This condition lasted through the Cincinnatian period when the Utica, Frankfort and Pulaski shales of central New York were laid down. In the Hudson valley and eastward there was a marked preponderance of shales over limestones in the sedimentation throughout the whole Lower Siluric period; the great mass of shales which has come to be known as the Hudson River formation began to be deposited in fact as early as Cambric time.

At the close of the Lower Siluric period, the Taconic disturbance interrupted sedimentation in the area along the Hudson river and upraised that section into dry land. The agencies of compression and metamorphism which were forceful enough to produce a highly folded and more or less metamorphosed condition in the shales, limestones and sandstones of the east did not extend their effects very far to the west. The Adirondack and Mohawk valley formations were not changed noticeably or disturbed from their normal position, though possibly there was some faulting which initiated the great meridional breaks along the eastern and southern Adirondacks. In the Highlands regions the effects may have been much more pronounced, as indicated by the intrusion of the great boss of the Cortland rocks. Other deep-seated invasions may be represented by the serpentine masses of Staten Island and Rye and by the Harrison diorite, though these are possibly of earlier date.

The Ontario or Upper Siluric period was continuous with the Lower Siluric as regards sedimentation in the interior of the State, though on the borders of the Taconic land surface the two series of formations are separated by a strong erosional unconformity. The Upper Siluric was a time of shallow water accumulations. In the basal members, as represented by the Oswego and Medina

sandstones and the Oneida conglomerate, the materials consisted largely of the coarser detritus washed down by rapid streams and deposited close to the shores. The Medina, however, contains much shale near the top. The Niagara formations are mainly shale (Clinton and Rochester) and dolomite (Lockport and Guelph). During Clinton time, the waters were probably rather shoal with off-shore bars sheltering them from the sea as indicated by the precipitation of iron ores along with sandstones, shales and limestones. The formations up to the Guelph had been deposited along a nearly east-west shore line that lay to the south of the Canadian and Adirondack highlands; they are now found in belt-like areas extending across the central and western parts of the State. In the Cayugan period the zone of sedimentation extended into southeastern New York on the shore of the Appalachian protaxis. The Salina shales formed at the opening of the period are characterized by the deposits of rock salt and gypsum which probably resulted from the evaporation of the sea waters in confined basins. The succeeding formations include the Cobleskill, Rondout and Manlius limestones. The Medina sandstone at the base of the Upper Siluric is one of the more important building stones in the State and the various limestones named find utilization for lime, cement or constructional purposes.

The change to Devonic time was very gradual and no break occurred in the sedimentation. In the first or Helderbergian period the deposits were mainly calcareous and restricted to the central and eastern parts. The Oriskanian period began with limestones, but afterward the Oriskany sandstone, a very persistent, chiefly arenaceous, formation was deposited. To Ulsterian time belongs the Onondaga limestone, one of the very important calcareous formations, largely quarried in the central and western sections. With the Erian period began the accumulation of the great series of Devonic shales and sandstones that spread over the whole southern plateau section of the State from the Catskills and Helderbergs west to the Pennsylvania border. The sandstone members are the bluestone quarried for flagging, curbing and building stone and range in age from the Hamilton in the Erian period to the Chemung at the top of the Devonic. In the Senecan period occurred an interval of limestone deposition in the central part represented by the Tully limestone.

The Carbonic era introduced at the start no marked variation in the sedimentation. The representatives include shales and sandstones with conglomerate at the top; the last being the equivalent

of a part of the Pottsville conglomerate in Pennsylvania. There are no coal beds anywhere exposed and the conditions requisite for their production did not become very general until after the last of the local beds were laid down. The Carbonic strata are limited to a small area in the extreme southwestern section. The long lapse of time that ensued to the close of the Carbonic and all of the following Permic era find no record in the strata of New York State.

The Appalachian revolution brought Paleozoic time to an end and marked the final emergence of practically the whole mainland area of New York from the sea. The disturbance resulted in a broad uplift in the central and western parts of the State, but no change in the relative attitude of the formations. In the southeast, however, along the main axis it developed in some folding as shown by the Shawangunk mountains.

Mesozoic time was marked by only slight additions to the geological structure of the State. The Newark shales of late Triassic age, which occur in Rockland and Richmond counties were probably formed in estuaries along the coast. During and after their deposition, igneous activity was manifested by the intrusion of diabase which, in places, reached the surface. The Palisades consist of the exposed edge of a diabase sill intruded along shale and sandstone beds of Newark age. With the last, or Cretacic, period of Cenozoic time came the deposition of the older clays of Staten Island and Long Island.

During the Cenozoic interval there were small accumulations of Tertiary clays in the same areas. The most important event of the era in its influence upon the local geology occurred in the Quatenary period with the change of climate that brought on an ice invasion. This advanced from north to south and spread over the whole State, overriding even the higher mountains. The ice eroded away the loose materials accumulated by weathering and also transported immense quantities of rock which it plucked from the bared surfaces. The contours were rounded off and the land covered with a mantle of clay and boulders (till), the transported materials being also heaped up in the form of hills and ridges which are known as moraines and drumlins. The drainage was also obstructed or remodeled; some large lakes occupied the main river valleys for a time, as in the Hudson valley. The main effect of the ice upon the rock surface was to remove the evidences of the long preceding period of weathering; consequently the rock outcrops appear much fresher than they do in the unglaciated territory to the south of New York.

Section 3

THE CRYSTALLINE SILICATE ROCKS

PRELIMINARY DISCUSSION AND DEFINITION OF TERMS

Before entering upon the description of the different quarry materials, it may be well to explain that the classification of rocks into three principal groups — igneous, sedimentary and metamorphic — which has been followed hitherto scarcely serves the purpose of an economic classification that is based on general quarry features and uses. From a practical standpoint, there is no line of division to be drawn between many metamorphic gneisses and schists and the igneous rocks, since they may have the same applications and present the same problems in quarrying and dressing. It is customary, therefore, to include the metamorphosed silicate rocks which are useful for structural stones with the massive igneous types, and that practice will be followed here.

The other metamorphic rocks include slates which are placed in a separate division, marbles which with some nonmetamorphic limestones are also separately described, and quartzites which from an economic point of view belong in the class of sandstones.

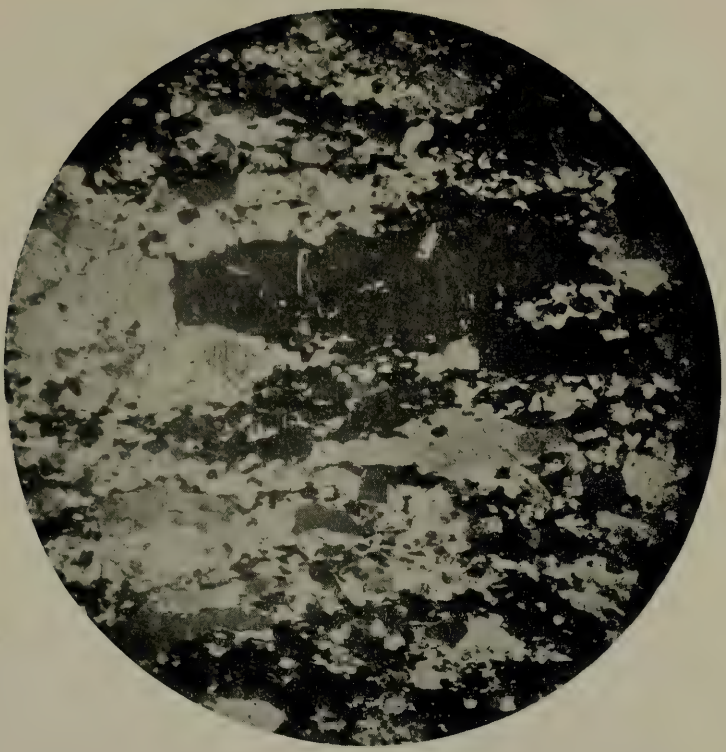
The crystalline silicate rocks of the Adirondacks and southeastern New York embrace a variety of individual types such as granite in the strict sense, syenite, diorite, anorthosite, gabbro of different kinds, diabase, and an assemblage of gneisses and schists that includes both igneous and sedimentary derivatives of varied mineral composition.

GRANITE

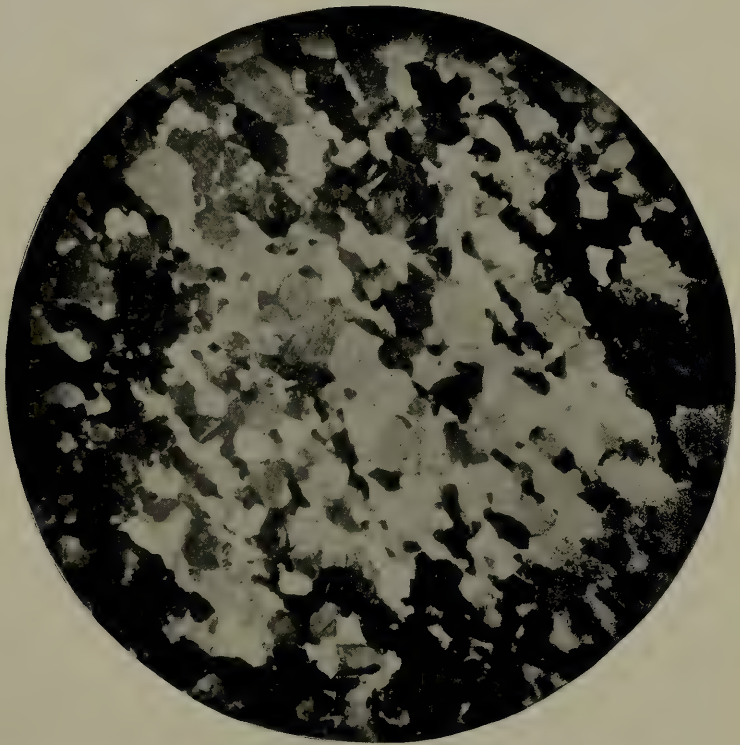
As an architectural stone, granite outranks the other igneous rocks of the State, which is true also wherever the crystalline silicate rocks are exploited. Its prominence is due in part to its relatively widespread occurrence, but largely to the combination of qualities in regard to color, uniformity and ease of extraction and dressing which is less often found in the other stones. The prevalent taste for light-colored stone in buildings has much to do with its general favor.

Although quarrymen and builders use the term granite rather indiscriminately to designate almost any of the silicate rocks that have been named, it probably belongs to a single rock series of igneous origin which is characterized in composition by the presence of potash, feldspar and quartz. These two minerals always predominate, but are often accompanied by others in greater

Plate 5



Photomicrograph of granite gneiss, Little Falls. Large particles are quartz and the rest mainly feldspar. Enlarged 22 times.



Photomicrograph of Yonkers granite. The components are quartz, feldspar and mica. Enlarged 22 times.

or less quantity, especially plagioclase, which may share importance with the potash feldspar, and by mica, hornblende or, rarely, pyroxene. The potash feldspar is either microcline or orthoclase, the former being the more common. Mica occurs in two forms — the white or transparent muscovite and the black biotite; usually both are present, but if one alone occurs, it is more often biotite. Hornblende is a rather common ingredient of local granites in which it replaces the mica wholly or in part. Pyroxene, which resembles hornblende in appearance when seen in the hand specimen, is restricted to a few types which are related to the syenites.

Besides the more important or *essential* ingredients named, granites usually contain a number of others in very small amount which may be called *accessory* constituents. Such are apatite, zircon, rutile, magnetite, pyrite, fluorite, tourmaline and garnet. There may be also various *secondary* minerals which have been derived by chemical alteration from some of the original constituents; thus sericite, kaolin and calcite result from the alteration of feldspar, and chlorite, serpentine, epidote and iron oxides result from the dark iron-magnesia minerals.

The chemical composition of various local granites will be found under the quarry localities elsewhere in this volume.

The texture of granite is usually even-grained, with the feldspar and quartz in particles of nearly the same magnitude. There is no regularity, however, as to the size of the particles in granites from different localities, and there is likely to be more or less variation in that respect in different parts of the same mass. A granite may be said to have a *coarse* texture if the crystals of quartz or feldspar average over 10 mm or 0.4 inch in diameter; *medium* if the crystals range between 10 mm and 5 mm; and *fine* if they are less than 5 mm. In the very fine sorts, the crystals average under 1 mm. The same rule for classifying textures will be applied to the other quarry stones.

The specific gravity of granite varies from about 2.5 to 2.75. This corresponds to a weight, without allowance for porosity, of from 156 to 172 pounds to the cubic foot. The average weight is about 165 pounds, and a cubic yard in the quarry may be taken roundly as equal to 4500 pounds.

Granites are white, gray or pink in color, with occasional examples showing a bright or deep red. The feldspar is the main coloring agent, as it predominates over the other ingredients, but the general color effect is really a combination of the individual colors of the minerals. Muscovite and quartz are colorless or translucent

white, and the iron-bearing ingredients (biotite, hornblende and pyroxene) are usually black. By alteration to sericite or kaolin, the feldspar loses its naturally brilliant luster and becomes opaque and earthy. The coloration of some granites arises from infiltration of iron compounds in sufficient amount to overcome the color values of the silicates and impart their own effects. This is well instanced by the yellow Mohegan granite from near Peekskill, the beautiful color of which is traceable to a little limonite that has found its way into the stone by means of the capillary pores. That the color is not due to local alteration of the minerals is very apparent from examination of thin sections which show the only iron-bearing silicate (biotite) to be quite fresh in most of the stone and only occasionally is a local deepening of the color observable about that mineral. At the surface the biotite shows some alteration with the production of chlorite, but there is very little iron discharged in the process, altogether too little for the amount of limonite distributed through the body of the rock. Apparently the iron has come from above, probably introduced in solution as a ferrous compound to be subsequently oxidized to limonite.

SYENITE AND ANORTHOSITE

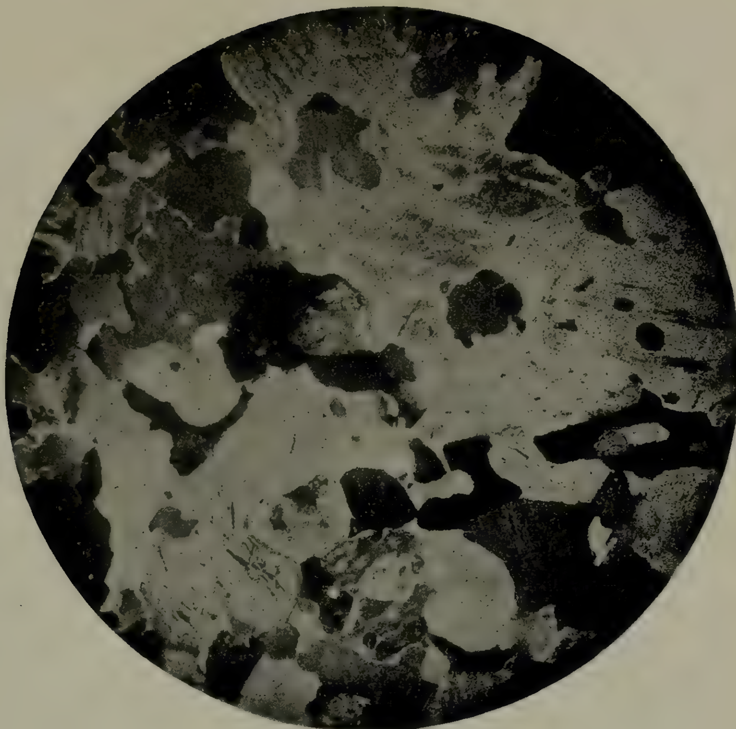
Syenite and anorthosite belong to separate rock series but, from a practical standpoint, are much alike. Both consist of feldspar as the essential ingredient, with accessory hornblende, biotite, pyroxene and magnetite. In syenite, the feldspar is an alkali variety, either microcline or orthoclase, or an intergrowth of one of these with albite, known as microperthite. Anorthosite, however, consists of a basic plagioclase, usually labradorite, with one or more of the iron-bearing silicates and usually ilmenite in the place of magnetite.

Their structure is mostly even-granular and compact. As to strength and durability, they are nowise inferior to the granites, if not exceeding them in some elements which make for permanency. In specific gravity they average a little higher than the latter and range from about 2.65 to 2.90, with 2.75 perhaps as a mean value. Their weight is accordingly around 175 pounds to the cubic foot.

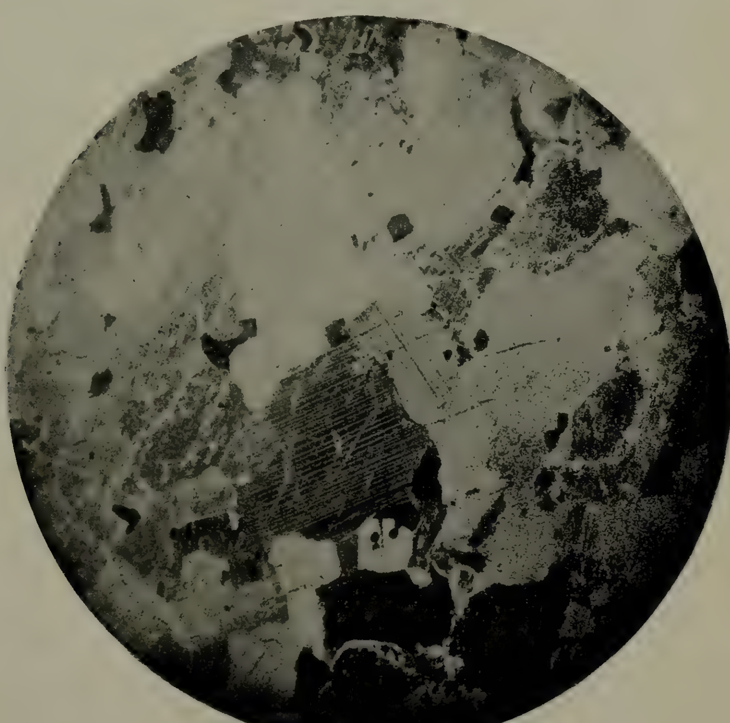
They are not so abundantly distributed as granite, but where they occur they constitute equally large bodies, sometimes forming bosses and bathyliths of great size.

The color of syenite, and of anorthosite as well, is darker than that of average granites. Green and blue tones are not rare, and the luster from the feldspar is often very brilliant, making the

Plate 6



Photomicrograph of green syenite, Ausable Forks. Mostly feldspar, with some quartz and pyroxene. Enlarged 22 times.



Photomicrograph of anorthosite, Split Rock. The main component is labradorite which appears stratiated. Enlarged 22 times.

stone serviceable for polished and decorative work. The deep green of the Adirondack syenite is very characteristic. Anorthosite is either gray or dark green, the latter being characteristic of the feldspar in its original state, while gray is peculiar to the crushed and recrystallized varieties. The uncrushed feldspar shows the blue iridescence common to labradorite which adds much to the beauty of polished samples.

There are no peculiarities in the weathering of the two rocks, and they yield the same decomposition products named under granite. On the whole, syenite appears more resistant to frost action than the latter, at least it seldom breaks up into a granular aggregate which not infrequently marks the outcrop of granite bodies. As to the durability of anorthosite, little can be said from the point of practical experience since it has not been used very long for outdoor work. The rock, in place, shows little change on the surface. At Augur lake, near Keeseville, there are vertical cliffs of anorthosite which have been directly exposed to the weather ever since the glacial period; these show a bleached film not more than one-fourth of an inch thick coating the surface, but no stain or softening. This appears a favorable indication of its permanency under atmospheric conditions.

DIORITE

The name diorite is used to denote a rock containing plagioclase and hornblende as essential minerals. The plagioclase is nearer the albite than the anorthite end of the series, including such varieties as oligoclase and andesine; the hornblende is the same kind that accompanies syenite or granite and is usually plentiful. The color, consequently, is rather dark, with the grayish tones predominating. Some diorites contain considerable biotite which, if it gains ascendency over the hornblende, makes a mica-diorite as distinguished from the hornblende type which is simply a diorite. The composition of the diorite is intermediate between that of granites on one side and the gabbros on the other, and it might be expected to find gradation toward either series, through the appearance of certain characteristic minerals. The mingling of quartz and alkali feldspar makes a rather common variation from the type, leading to the class of granodiorites which may be described equally well as basic granites.

The diorites are not common rocks in this State. There are no large areas of typical massive diorite; some of the gneisses in the Adirondacks are related to diorites in mineral composition, having perhaps originated from such rocks, though now changed to the

gneissoid somewhat altered forms which are commonly termed greenstones. The characteristic green hue of these altered types is due to the formation of a chloritic mineral out of the hornblende or biotite.

Granodiorite is represented by the great area of so-called Harrison diorite in Westchester county and by smaller masses in both the Adirondacks and southeastern New York.

The physical characters of diorites are not very different from those described under granites; in the case of granodiorites the resemblances are very close. They are a little darker in color, never appearing in reddish tones, but always grayish or greenish; average around 2.8 or 2.9 in specific gravity, corresponding to a mean of about 180 pounds to the cubic foot; and are useful for all purposes to which granites are put, except they are less readily polished, owing to the presence of so much hornblende and mica.

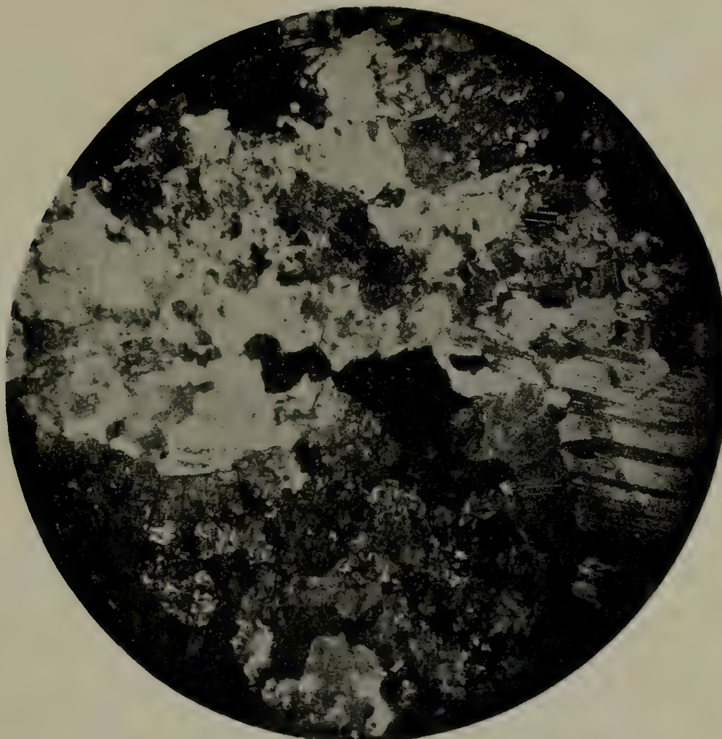
GABBRO

Gabbro is composed typically of pyroxene and plagioclase, the latter being one of the more basic varieties—labradorite or anorthite. Unlike the rocks previously described, it usually contains more of the iron-bearing silicates than of feldspathic minerals and hence the color is very dark, ranging from grayish or greenish gray to black. The pyroxene includes both orthorhombic and monoclinic varieties which very frequently show partial alteration to hornblende. Olivine is a common and at times an important ingredient; its presence is denoted by a prefix to the rock named, for example olivine-gabbro.

Gabbros are peculiarly subject to fluctuations in mineral composition through a relative gain in the proportion of one or another of the common minerals, a variation caused by some process of differentiation during the period of intrusion and consolidation. By increase of the feldspar and corresponding shrinkage in the pyroxene there results the rock already described as anorthosite. This is really, therefore, a gabbroic type and not related directly to syenite. The predominance of pyroxene leads to pyroxenite, in which feldspar is very sparsely if at all represented. Olivine, with subordinate amounts of feldspar and pyroxene, forms a peridotite. The principal iron ore in gabbro is ilmenite which may be sufficiently concentrated locally to form fairly pure masses of considerable body.

The gabbros, owing to their content of the iron-magnesia silicates, are rather heavy, averaging from 2.8 to over 3 in specific gravity. Their weight ranges from 175 to 200 pounds to the cubic

Plate 7



Photomicrograph of gabbro, Port Henry. Constituents are pyroxene, feldspar and magnetite.

Photomicrograph of diabase, Fort Ann. Lath-shaped crystals of feldspar in a groundmass of pyroxene. Enlarged 22 times.

foot. In fresh condition they are fairly hard and exceedingly tough, but lose these qualities rapidly if decomposed by atmospheric weathering. Their decomposition is sometimes hastened by the presence of sulphides, which are likely to be abundant in places, more so than in acid rocks. The characteristic alteration product of the more basic gabbros is serpentine.

Gabbros find little employment for architectural work, owing to their somber appearance. They are used to some extent for decorative and monumental purposes under the trade name of "black granite." Quarries in Maine, Minnesota and North Carolina have supplied such stone, but very little has come from the large gabbro areas of New York. The main developments in this State have been for the supply of crushed stone for macadam and concrete, for which purposes the fine-grained dense sorts may be considered equal to the best trap.

The limited use of the stone for general purposes is partly due, no doubt, to the expense of dressing it. The basic rocks seldom show any rift or grain structure, but break with a curved fracture without reference to direction.

DIABASE OR TRAP

Trap is a popular term for the dark, fine-grained igneous rocks that occur in intrusive sheets and dikes. It is thus not a distinct rock type, but may include diabase, basalt and any of the basic intrusions which have a sheetlike form. In New York State, the name is equivalent practically to diabase, an intrusive containing lime-soda feldspar and pyroxene as essential ingredients, with subordinate amphibole, olivine and pyroxene. The composition thus is very similar to that of gabbro, but the appearance of the rock is quite characteristic, owing to the manner in which the minerals are distributed. The feldspar forms laths or rectangular rods that inclose the pyroxene, olivine and amphibole in their irregular interspaces like a network. This gives a firmly interlocked texture which insures a high degree of toughness and resistance to abrasion.

Diabase is almost black on rock face and polished surfaces. Like gabbros, it finds limited employment for structural stone. Its specific gravity is about 2.9 and the weight around 180 pounds to the cubic foot. Its fine grain promotes evenness of wear, so that with its other qualities it is exceptionally well adapted for road material and concrete in all cases that involve heavy duty. Some examples make a good black granite, as shown by specimens of

the polished Palisades stone in the State Museum. Ordinarily it has no rift or grain and hence is difficult to reduce into dimension blocks; in some quarries, however, the stone splits readily enough to be converted into Belgian blocks.

The main area of diabase in this State is the Palisades intrusion, a long north-south sill or sheet lying within shales and sandstones of Triassic age and extending from Haverstraw to near Richmond on Staten Island. The sill is from 300 to 800 feet thick. Its exposed eastern edge with its vertical joint systems, forms the precipitous cliffs of the Palisades. This area has been a prolific source of crushed stone which has been used in road-making and concrete throughout the lower Hudson valley. There are countless numbers of diabase dikes in the Adirondacks, particularly in the northern and eastern sections, but they are mostly small, averaging only a foot or two thick, occasionally reaching 20 or 30 feet, and in one instance at Little Falls, nearly 100 feet.

GNEISS AND SCHIST

Gneiss and schist are general terms applied to the metamorphic silicate rocks whose original characters of texture, structure and, not infrequently, mineral composition have been more or less completely changed under influences of compression, heat and chemical agencies. Their chief structural peculiarity arises from a parallel arrangement of the minerals, the light and dark components being segregated in lines or bands which simulate the bedded structure of sedimentary rocks. The planes of segregation, as in the case of bedded structure, mark the directions of actual or potential parting; the schists, particularly, have a very well-developed capacity for splitting which resembles slaty cleavage in its perfection.

The gneisses of more massive type are suitable for general construction purposes but ordinarily do not lend themselves to decorative uses on account of their lack of uniform texture and appearance, both of which vary with the direction of view. Such kinds are mainly derived from granite and other massive igneous rocks. Under the influence of powerful compressive forces, the originals have been squeezed and stretched, bringing the scaly and elongated minerals into parallel alignment and crushing the rest into granular aggregates. The change may be not altogether a physical one, but is generally accompanied by the development of new minerals and more or less recrystallization of the mass. If the massive rocks originally had a coarse or porphyritic appearance, very often there will remain shattered but still distinct crystal aggregates of the

porphyritic mineral in the midst of the finer material. This is particularly observed in the metamorphic products of feldspathic rocks like granite and syenite which often show lenticular remnants of the original porphyritic feldspars and are known as "augen" gneisses.

Gneisses have all the variations in composition that are found in the igneous rocks. Those of granitic composition are naturally the most important for quarry purposes. Many of the granite masses show gneissic phases on their borders, as is the case also of the syenites, gabbros etc., the parallel lamination arising from differential compression during consolidation or later. In some places gneisses are formed by the injection of igneous material into a hornblende or mica schist that is itself a modified sediment. There are many such occurrences in the Adirondacks in localities where the Grenville schists have been invaded by granite; the latter apparently in its cooling has given off solutions charged with mineral materials which penetrated into the schist for long distances and converted it into a firm, hard gneiss. The so-called granite from Horicon is really an injected mica schist, with porphyritic feldspars and quartz derived from igneous sources. The Manhattan schist and Fordham gneiss as represented in most of the quarry localities contain a large proportion of granitic material interleaving or commingled with the ingredients from sedimentary sources, and it is by reason of this injection that they are serviceable quarry stones.

SERPENTINE

The mineral serpentine is formed almost entirely by alteration of other ferro-magnesian silicates, chiefly pyroxene and olivine. The latter minerals, as has been noted already, are important constituents of the basic igneous rocks of the gabbro family, some members of which are made up wholly of them: Their alteration, which is a process of hydration largely, with the separation of more or less lime as calcite and of some of the iron as iron oxides, takes place readily under atmospheric weathering and leads to the formation of extensive bodies of rock serpentine that has some use for architectural and decorative purposes.

There are several areas of serpentine in southeastern New York, of which the largest is on Staten Island, covering all the higher central part of that island. Other bodies are found on Manhattan island (now concealed), at New Rochelle and Rye. The rock in these places has little economic importance, owing to its badly

jointed and fractured condition. Serpentine is one of the softer minerals and on that account the rock can not be applied to general constructional purposes, but finds a market chiefly as an ornamental material by reason of its lustrous green color and of the striking pattern produced by the blotches or veinings of iron ores and calcite.

Besides this kind of serpentine, mention may be made of serpentinous marbles or ophicalcites which are derived from impure sedimentary limestones. In the metamorphism of the limestones, pyroxene is formed which later changes over to serpentine, giving a mottled or spotted effect of green on a white body of calcite. Such serpentinous marbles occur in the eastern Adirondacks and have been used to a limited extent for monumental and interior decorative work.

PEGMATITE

Pegmatite is really a member of the granite series, being a coarse-grained intrusive composed of feldspar, quartz and mica. It has little value for structural purposes which granite serves, and in its mode of occurrence and origin differs somewhat from the ordinary representatives of that series. It is found in dikes with fairly regular tabular form, but also occurs in irregular winding veins and occasionally in masses that show a lenticular or rounded outcrop like bosses of the finer grained igneous rocks. The latter type may attain very large proportions, that is a thousand feet or more in diameter, while the dikes seldom exceed 40 or 50 feet in thickness and for the most part are under 10 feet.

The mineralogy of pegmatites is of much interest on account of the variety and fine crystallizations of the species that accompany them. The important species, however, are the same as those described as essential constituents of granite. The quartz is commonly white, gray or pink, occurring in crystals or massive, and ranging from a few inches to several feet in diameter. It is also more or less intergrown with the feldspar, sometimes in a peculiar way which is known as "graphic granite." The feldspar includes the alkali varieties like microcline, orthoclase and albite, with usually more or less of lime-soda feldspar of oligoclase or andesine nature. Individual crystals sometimes measure 5 or 6 feet long. Both the quartz and feldspar are valuable where they can be obtained in condition of fair purity and uncontaminated by iron; their principal use is in pottery, but they serve many other purposes. The mica of pegmatite belongs to both the lighter iron-free sorts like muscovite and phlogopite and the dark variety biotite; it builds

sheets and thicker plates that attain a size up to 2 or 3 feet across. Its occurrence in pegmatite is the source of commercial mica, but the mineral has to be free of inclusions and checks to be of much value, which is very rarely the case in any of the Adirondack pegmatites.

In addition to quartz, feldspar and mica, there are a great many minerals that occur in more or less abundance in the local pegmatites. Some of the commoner ones are tourmaline, beryl, garnet, amphibole, magnetite, pyrite, apatite, zircon, titanite, lepidolite, chlorite, epidote and calcite; of rare occurrence are monazite, xenotime, autunite, dumortierite, molybdenite and allanite. The crystals of tourmaline and beryl may weigh many pounds.

Pegmatites are quite variable in their composition, changing much more rapidly in that respect than granite. The proportions of feldspar and quartz fluctuate through all possible ranges, as may be seen in almost any of the larger bodies like those at Crown Point and Bedford, for example. A mass of practically solid feldspar in one place gives way in a short distance to one of quartz or to a mixture of the two minerals. These fluctuations take place horizontally and vertically and often are the cause of much inconvenience if they do not seriously affect the progress of quarrying, especially where it is aimed to secure a uniformity of products. In many quarries this feature seems to have been ignored at first, and the results of work consequently have not corresponded to expectations. There is need of careful investigation to determine the character and uniformity of the materials in each locality which should precede actual development. Bosses and large dikes of pegmatite extend downward into the earth for indefinite distances, usually much farther than they can be followed in open quarry operations. The lenses and veins are much less persistent, often pinching out abruptly.

Pegmatite is associated with many of the granite areas in the Adirondacks and southeastern New York. In most of the granite quarries small irregular masses of the material are encountered, in some with such frequency as to impair the value of the product. In the larger occurrences the pegmatite may be left as a wall in the quarry. The irregular bodies which grade over into the granites are apparently not intrusive in the latter, but have resulted from crystallization of the magma in place, the coarse texture being due to the local presence of abundant water vapor and other mineralizing agencies. The pegmatite is probably the last part of the mass to crystallize and represents the residue of magmatic material with

an excess of the solvents or mineralizers squeezed out by the consolidation of the surrounding granite.

The larger bodies in the form of dikes or bosses represent real intrusions of much later age than the country rock. They occur in any kind of country rock, be it gneiss, schist or limestone. Consequently they are sharply delimited on the borders, without any gradation as is observed in the segregated bodies. They are offshoots of some granite mass which may be quite distant or not at all in evidence at the surface. All through the western Adirondacks, but particularly in St Lawrence county, dikes, veins and bosses of pegmatite occur intersecting the older gneisses, and schists, with only here and there a body of granite in evidence that may be regarded as a source of the materials. It is very probable that much of this region is underlain by a great granite bathylith of which the exposed granites and pegmatites are offshoots into the overlying rocks. The larger pegmatite bodies are often conspicuous features in the topography, as they are very resistant to erosion and tend to form knobs and ridges. They are consequently most frequently encountered on the higher ground and when uncovered may be visible for long distances, on account of their white color.

Fig. 6 Map of the St Lawrence river granite quarries. 1, Picton island; 2, Forsythe; 3, Kelly; 4, Webster quarries.

Section 4

FIELD OCCURRENCE OF THE GRANITES, GNEISSES, TRAPS, ETC.

THE ST LAWRENCE RIVER GRANITES

Granite and granitic gneiss are exposed on several of the larger islands in the St Lawrence river, particularly in the stretch from Clayton to Alexandria Bay and over a considerable area on the adjacent mainland. They are outlying representatives of the Adirondack crystallines, though separated from the main area of the latter by an interval in which the surface formations consist mainly of undisturbed Paleozoic sediments. These rocks undoubtedly covered the whole region at one time, but have been eroded away here and there so as to expose the underlying Precambric basement. In contrast with the Adirondacks, the Precambric area along the St Lawrence presents very little relief, for the most part being less than 100 feet above the river and much of it is quite flat. Suitable quarry sites are therefore not so common in this section as in the interior highland where rocks of similar or identical character occur, but the region is favored by the facilities for water transportation which give access to the important markets on the St Lawrence and Great Lakes at very low rates.

The most valuable quarry material in this section is the red granite of Grindstone, Picton and Wellesley islands, a product with which the name Thousand Island granite is popularly associated. It has had a fairly large sale for building and monumental purposes, taking rank with the best of the red granites from American quarries. In general it is a bright red, coarsely textured rock, but medium-grained and fine-grained varities also occur. It has a thoroughly massive appearance, and the grain is very uniform so far as relates to the product of a single quarry.

The present exposures of this granite have been traced on the geological maps prepared by Cushing and others for the report on the "Geology of the Thousand Islands Region."[1] The granite extends from the central part of Wellesley island, where it is in contact with the older granitic gneiss series, to the western limits of that island, and reappears on Grindstone, of which it constitutes

[1] N. Y. State Mus. Bul. 145, 1910. The red granite lies mainly within the Grindstone quadrangle.

the larger part. It also outcrops on the smaller islands between Wellesley and Grindstone, including Murray, Picton, and Bluff islands.

GRINDSTONE ISLAND GRANITE AREA

Grindstone is an irregular, deeply indented island, about 5 miles long and 2 miles wide, lying nearly midway in the river, directly opposite Clayton. It is included in the Grindstone quadrangle of the United States Geological Survey. The island is low and thinly soiled, though it affords some good grazing and agricultural land. The principal settlement is Thurso on the north shore and near the western end.

As shown on the geological map by Cushing and Smyth, the red granite occupies all the eastern and northern part of the island, but on the south and west gives way to the older Grenville and Laurentian gneiss series, into which, however, it sends offshoots that in places are of considerable magnitude. It is also not unmixed with these rocks, as inclusions of the Grenville schist and quartzite and of the lighter Laurentian granite are found within the interior of the red granite. These inclusions appear, however, to be arranged in definite belts and are not so generally distributed as to give trouble in quarry operations, if a little care is exercised in the selection of a site. Aside from these larger inclusions the granite shows a fair degree of uniformity. Occasional "knots" of darker color are noticeable in some of the quarries and seem to be in the nature of segregations.

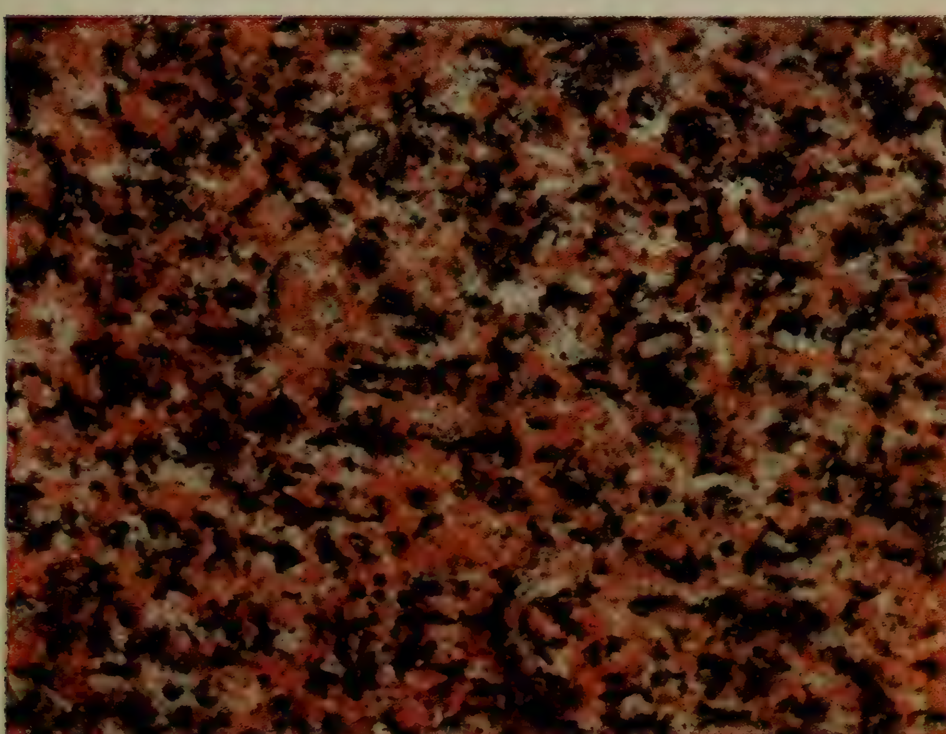
The principal quarry workings are in the vicinity of Thurso. For the last few years none of the quarries have been actively operated, though some stone is taken out occasionally on orders for building and monumental work. The period of greatest activity dates back fully fifteen years. In Smock's report of 1888 it is stated that quarries had been opened at more than twenty different places on the island and that three large quarries were then in operation.

General character and composition. The Grindstone Island granite usually has a coarse texture which is imparted by the abundant large feldspar individuals. It has, nevertheless, excellent polishing qualities, giving a fine and lustrous surface. The color is bright red for the polished surfaces but lighter on the rock face and very light on hammered work. The stone is therefore suitable for buildings in which a medium color effect is desired and at the same time is well adapted for monumental or interior work.

The mineral composition of the granite is somewhat variable

Plate 8

Pink granite. Picton Island, St. Lawrence river



Red granite. Picton Island, St. Lawrence river

according to locality, but in general it may be said that red feldspar constitutes about three-fourths of the whole, while quartz and biotite are next in abundance. The feldspar consists of microcline, microperthite, and oligoclase and shows some alteration. The quartz has a bluish or opaque white color. Along with the biotite there is some chlorite, evidently from alteration, and hornblende. The minor ingredients include magnetite, titanite, pyrite, zircon and apatite. The feldspar shows incipient decay, but is not materially softened.

The following chemical analysis is taken from Cushing's "Geology of the Thousand Islands Region." It is based on a sample from a quarry described as 1 mile southeast of Grindstone, perhaps referring to the Gordon quarry. The analysis is by E. W. Morley.

SiO_2	66.59
Al_2O_3	14.54
Fe_2O_3	2.42
FeO	2.43
MgO	1.18
CaO	2.15
Na_2O	3.08
K_2O	5.62
H_2O	.46
TiO_2	.81
P_2O_5	.40
Cl	.03
F	.06
S	.08
MnO	.23
BaO	.17
	100.25

Laboratory tests. Acording to Smock, a representative specimen of the granite showed a specific gravity of 2.713, equivalent to a weight of 169 pounds to the cubic foot. The absorption was 1.55 per cent of water. When subjected to a dilute solution of sulphuric acid, the loss was .13 per cent. No apparent change was caused by freezing and thawing, but exposure to a temperature of 1200°–1400° F. caused vitrification, destruction of color and impaired the strength.

A more elaborate test of the fire-resisting qualities of the granite was carried out by Mr W. E. McCourt. Two cubes tested to 550° C. with slow cooling remained unchanged, but one developed a few

small cracks when rapidly cooled from that temperature. Cracks appeared in the cubes when heated to 850°, and under the flame and water test the granite was badly broken as was the case with all the cubes of igneous rocks that were subjected to that test.

The absorption of 1.55 per cent as given by Smock seems to be erroneous, perhaps due to the shifting of the decimal point. So large a ratio is seldom found in any granite. Physical tests of the granites by the writer gave the following values: specific gravity 2.71; ratio of absorption .171 per cent; pore space .462 per cent. In his "Building and Ornamental Stones of Canada," Parks includes the following data for the Kingston granite which apparently is almost identical in composition with the Grindstone granite; specific gravity 2.68; ratio of absorption .119 per cent; pore space .319 per cent; crushing strength 30,421 pounds a square inch.

Kelly quarry

Most of the stone shipped from the island in recent years has come from the Kelly quarry. This is also known as the Chicago Granite Company's quarry. It was opened about 1883 and worked by that company for several years. The present owner is H. B. Kelly of Clayton. The quarry lies on the southern and western slopes of a hill which fronts the little bay reaching southward toward Thurso. It is opened in two benches with a total height of about 75 feet and a length of over 200 feet. The rock has a rather coarse grain and is thoroughly massive. The only defect is the presence of rounded inclusions, or knots, of darker, finer crystalline rock which cause some waste in the quarrying of dimension stone. The jointing is not particularly well defined or regular. The principal courses are N. 75° E. and north-south, with less plainly marked series N. 35° E. and N. 50° W. The joints are widely spaced and permit the quarrying of blocks of large size. Sheeting is absent though there is an imperfect division along a plane which dips 15° or so to the north.

The present equipment includes one 40-foot derrick. The shipping dock is a few hundred feet north of the quarry and connected by a tramway. The quarry lands compose about 5 acres.

Paving blocks were the principal product made by the Chicago Granite Company. They were shipped chiefly to cities on the Great Lakes. Under the present ownership, monumental and building stock are quarried on a small scale. Several buildings along the St Lawrence have been constructed of this granite.

Forsythe quarry

The Forsythe Granite and Marble Company of Montreal operated at one time a quarry just north of Thurso and across the bay from the Kelly quarry. The shore on the west side of the bay rises abruptly 50 feet or more above the water, admitting of a good face directly at the shore line. The quarries extend north and south for about 200 feet. The rock is a little darker on the average than the granite of the Kelly quarry, but otherwise is very similar. The joints are even more widely spaced and indefinite. The more persistent courses are N. 45° W. and N. 40° E. The grain runs parallel with the latter. Blocks can be obtained of size limited only by the means of handling. The presence of inclusions of darker color is the principal defect. There is a little pyrite noticeable in some of the rock, but it is too small in amount to exert any detrimental effect in the durability or color of the stone. This is apparent in the freshness of the rock at the surface.

The granite at this quarry shows two varieties of texture, the one being characterized by coarse feldspar crystals of from 10 to 15 mm diameter and the other by medium-sized crystals of approximately 5 mm diameter. The former found employment for monumental and building stone and the latter for paving blocks.

The quarry is probably the same as that described by Smock under the name of the Thousand Island Granite Company, and active at the time of his report. The quarry was opened about 1880. The product in the early years was mostly paving blocks and was shipped to western cities. Building and monumental stone were also shipped in quantity to Montreal.

The Forsythe Granite and Marble Company, the last to operate the quarry, ceased work over ten years ago. There is no equipment of value remaining on the property. The shipping dock is directly at the quarry. The quarry is now owned by Miss Jennie Forsythe of Montreal.

A sample of the polished granite from this locality is shown in the large columns that adorn the Senate Chamber of the New York State Capitol at Albany. These are said to have been quarried from near the surface.

Other quarries near Thurso

On the farm of W. L. Webster about one-half of a mile east of Thurso is a ledge of red granite, once worked by White and O'Brien. This quarry face is about 200 feet long and 20 feet high. The joint courses are well defined and run N. 60° E. and N. 30° W. There

is a fairly developed sheeting which dips 15° S. or nearly parallel to the slope, and facilitates extraction of the blocks. This stone is a little darker and more finely textured than at the other quarries visited, due to the increased percentage of the biotite and hornblende.

The quarry formerly worked by Gordon and Turcotte lies a little south of Thurso. It is perhaps the one described by Smock as situated about half a mile from the northwest side of the island, and known as the Gordon quarry. This was then operated by the International Granite Company of Montreal. Gordon and Turcotte ceased work about twelve years ago.

The Potter quarry, now owned by H. B. Kelly, lies about a mile southwest of Thurso and yields both red granite and a darker colored rock which is perhaps related to the Adirondack syenite but which was not seen in place. The latter stone is used for monumental work. The quarry has not been developed to any extent. The ledge is about 75 feet high and the quarry lands include 10 acres.

THE PICTON ISLAND AREA

The Picton Island Red Granite Company

The characteristic Thousand Island red granite is obtained at present in quantity only from Picton island, which yields medium-grained to fine-grained varieties as compared with the prevailing coarse granite of Grindstone island. Picton island lies about 3 miles north of Clayton, between Grindstone and Wellesley islands; it is called Robbins island on the United States Geological Survey map, though known locally by the former name. The quarries are on the northern end of the island, where the ledges rising directly from the shore line afford a face from 50 to 75 feet high, almost at the water's edge. There is little stripping or other preparation required, and the stone is loaded directly on boats from the quarries for shipment to river and lake ports. Rail shipments are made from Clayton, where the company owns docks and yards close to the railroad.

The Picton Island granite is a part of the same mass which outcrops over most of Grindstone Island and the southern end of Wellesley island. It is a closely textured, sound stone of attractive color, taking a lustrous polish and well suited for building and monumental work. Two varieties, medium-grained and fine-grained are obtained, the former having a bright red body flecked

with black, and the latter a uniform pink tint in which there is little but the coloration of the feldspar noticeable. The pink granite finds special favor for monumental purposes.

The company has two quarries in operation, of which the more northerly has been mainly worked and has yielded most of the stone of medium grain. The face here is about 300 feet long and 75 feet high. The vertical joints are rather widely spaced and run N. 45° E. and N. 35° W. The bed joints dip into the hill at an angle of 15° or more, causing some difficulty in loosening the blocks. Material of any size can be obtained. A small dressing and polishing works have been provided for turning out finished material. The granite had a well-marked rift and grain, so that excellent paving blocks can be obtained from the waste, but this product yields little profit at present owing to the competition which has arisen from the quarries in the south with their cheaper labor.

The more southerly quarry is in process of development. It has a face about 150 feet long and 50 feet high with a slope which will afford 25 feet or more additional height. The principal product is pink granite, though there is some red, medium-grained granite associated with it. About 10 or 15 feet of the surface rock is discolored by sap and has to be stripped before marketable material is obtained. The jointing here is irregular, with no predominant directions noticeable.

A third quarry is situated between the others, but was not worked at the time of inspection.

The company has a very complete equipment and can furnish rough and cut stone in almost any size and quantity. Some of the structures for which this stone has been used include the new portion of the American Museum of Natural History in New York, the National Bank Building in Clayton and the Maryland Museum Building in Baltimore (polished columns). The red granite suitable for polishing brings about $1.25 a cubic foot and the pink granite from $2 to $3 a cubic foot.

General observations. The color effect of the red granite is very similar to that of the Grindstone Island granite. The polished surface is bright red. The rock face and hammered surfaces are lighter than the polished and give a pleasing warm tone when seen in structures. The contrast between hammered and polished work, as exhibited in monuments, is marked.

The pink granite is considerably lighter than the red and, owing to its fine texture, appears to be of almost uniform body. When

tooled the color is pinkish white, and letters and designs stand out prominently from the polished surface. The stone is especially valuable for monuments.

Mineral and chemical composition. The Picton Island granite is essentially a mixture of feldspar, quartz and biotite, with no marked differences as regards composition between the red and pink varieties. The textures are even and thoroughly massive. The red or medium-grained variety is composed of particles averaging 5 mm in diameter and the fine-grained of particles averaging from 1 to 2 mm. The coloration is due to the feldspar ingredients which contain minute inclusions of hematite, magnetite, hornblende, garnet, muscovite, titanite, apatite and pyrite are present in small amounts. The pyrite is mostly limited to the joint surfaces and is so sparingly distributed as to exert no appreciable effect upon the durability and permanency of color of the granite.

The following chemical analysis by W. S. Hall of the Massachusetts Institute of Technology is abstracted from a circular issued by the Picton Island Red Granite Company:

SiO_2	69.20
Al_2O_3	13.80
Fe_2O_3	5.28
CaO	1.51
MgO	.77
K_2O, Na_2O	8.80
S	.04
H_2O and loss	.60
	100.00

The composition is normal for granite, with the exception of the iron which is a little higher perhaps than is usual in most granites. This is explained by the rather abundant magnetite, in which form the iron can exert no detrimental effect. Although the potash and soda are not separated in the analysis, the former probably predominates as the feldspar is mostly microcline and orthoclase with subordinate plagioclase. Treatment with acetic acid failed to give any reaction for carbonates.

Physical tests. According to information furnished by the company, the granite has a specific gravity of 2.653. A cubic foot accordingly weighs 165.81 pounds, which is about the average for eastern granites. The crushing strength, as determined in a cube taken from the quarries when first opened, is 16,500 pounds a square

inch. An absorption test on a 4-inch cube dried to constant weight and immersed in water for five days showed .023 grams of water absorbed for each square inch of surface.

Specimens of the medium-grained and fine-grained granites from these quarries were submitted for testing to the bureau of research, State Department of Highways with the following results:

	Medium-grained	Fine-grained
Specific gravity	2.655	2.64
Absorption, pounds a cubic foot	.06	.13
Hardness	18.8	18.9
Toughness	12.	13.5

ALEXANDRIA BAY AREA

An exposure of granite or granitic gneiss around Alexandria Bay has been of some importance in the quarry industry of the St Lawrence river region. It has furnished little building or monumental stone, but is chiefly valuable for paving material and rough work.

The granite differs markedly in appearance from the granite quarried on Grindstone and Picton islands, having usually a finer grain, lighter color and a texture that in places is distinctly gneissoid. The occurrence is described by Cushing under the name of the Alexandria bathylith and is placed by him in the Laurentian gneiss group, older than the characteristic massive granite of the neighboring islands. The fine grain, as well as the gneissoid appearance which it exhibits in some places, is a secondary feature superinduced by regional compression; occasional uncrushed remnants of larger crystals (mainly feldspar) are still in evidence. The composition is that of a typical granite, with feldspar, quartz and mica as the principal minerals, ranking in the order given.

The granite extends for several miles north and south of Alexandria Bay along the river. Few ledges suitable for quarry sites occur as the country is generally flat and the higher ground often is mantled by Potsdam sandstone which rests in horizontal beds upon the granite. Much of the rock, also, carries inclusions of darker color and is seamed with quartz and pegmatite.

Quarry of J. Leopold & Company

The principal quarry in the Alexandria granite is situated about one-half of a mile south of Alexandria Bay and belongs to J. Leopold & Company of New York. A knob of the granite rises 100 feet or more above the river, forming the most conspicuous ele-

vation in the vicinity. The bare rock is exposed on all sides of the knob which has a diameter in a northeast-southwest line of about one-fourth of a mile. A little bay sets in close to its base and forms a natural harbor accessible to river boats, which afford the only means of shipment. The main workings are on the east side where there is a cut 200 feet long. Smaller openings have been made on the top and north side.

The granite is well jointed, the main courses being N. 30° W. and N. 60° E. An indefinite sheeted structure appears in places. The structure and situation facilitate quarry operations and the only drawback is incident to the somewhat variable character of the stone which unfits much of it for anything but rough work. Two shades of granite appear in the quarries, one having a light gray color and the other a pinkish tint. Both varieties have the same composition and texture.

Microscopic examination. The appearance of the rock under the microscope is that of an originally rather coarse granite which has become finely textured through crushing and recrystallization. The process has not effected in this instance any noticeable parallel alignment of the minerals, but they show a compact arrangement conducive to strength.

The mineral composition indicates a biotite-muscovite granite of normal character. The feldspar is mainly of the alkali kind represented by microcline, microperthite and orthoclase supplemented by more or less lime-soda feldspar which appears to be oligoclase. It carries quartz inclusions and has a broken corroded appearance. Ferric oxide distributed along the fracture and cleavage planes of the feldspar is the coloring agent in the pink granite. The micas have only small representation and there is little magnetite or other accessory minerals.

Physical and chemical tests. In response to a request, Messrs J. Leopold & Company contributed the following data relative to physical tests of the granite which were made by the division of tests, United States Department of Agriculture, in Washington. The specific gravity is 2.65, corresponding to a weight of 165 pounds a cubic foot. Three cubes approximately 3 inches on a side were tested. Cubes no. 1 and no. 3 showed a strength of 17,780 pounds and 17,570 pounds respectively, for each square inch of cross section, or 20,860 and 22,220 pounds respectively for each square inch of bearing surface. Cube no. 2 resisted crushing to the breaking power of the machine.

The bureau of research, State Department of Highways, in its report for 1910 includes two tests of the Alexandria Bay granite, as follows:

	No. 1	No. 2
Specific gravity	2.64	2.64
Weight, pounds a cubic foot	165	165
Absorption, pounds a cubic foot	.17	.11
Abrasion, French coefficient	20.	17.4
Hardness	18.5	18.5
Toughness	8.	10.

A chemical analysis of the Alexandria granite, which is given in the Geology of the Thousand Islands Region, may be safely used in reference to the product of this quarry. The locality of the sample is given as one-fourth of a mile south of Alexandria Bay, thus in close vicinity to the quarry. The analyst is E. W. Morley.

SiO_2	73.10
Al_2O_3	14.29
Fe_2O_3	1.04
FeO	1.04
MgO	.53
CaO	1.18
Na_2O	3.08
K_2O	5.36
H_2O	.61
TiO_2	.18
P_2O_5	.03
Cl	.03
F	.02
S	.02
MnO	.07
	100.58

GRANITIC ROCKS IN THE WESTERN ADIRONDACKS

The western section of the Adirondack region, within the boundaries of St Lawrence and Lewis counties, is a complex of gneisses, schists, crystalline limestones and igneous intrusions, affording a considerable variety of quarry materials that are but little utilized. The only quarry developments of any importance in fact are based on the crystalline limestones which occur in belts, principally on the outer edge of the area. From these limestones are obtained excellent grades of building and monumental marble, of which the Gouverneur marble is the best example, as well as material for lime, furnace flux and road construction. The silicate rocks have received meager attention from an economic standpoint,

the only development consisting of temporary and small-scale operations to supply local needs in the way of road metal or foundation stone.

In its topography the region is a plateau which slopes to the west and northwest, the surface broken by ridges and hills of inconsiderable altitude. The elevation of the interior ranges from about 1500 to 2000 feet, while the outer border where the crystalline formations disappear beneath the Paleozoic sediments lies for the most part between the approximate limits of 400 and 700 feet, but is somewhat higher than that on the south. The interior is largely wilderness and accessible only in restricted districts where one or two branch railroads have been extended eastward from the main lines which skirt the borders. Of these, the Carthage & Adirondack Railroad belonging to the New York Central system is the more important and runs from Carthage at the contact of the Paleozoic strata with the Precambric complex in a direction north of east across the central part of the highland as far as Newton Falls near the outlet of Cranberry lake. The few small settlements that exist in the interior are mainly dependent upon lumbering and the summer visitor for support. There is little local demand for building material of permanent nature.

Of the crystalline formations the gneisses and schists are most prominent, but massive rocks occur in several rather extensive areas. Granite, syenite and gabbro are the principal representatives of the igneous rocks. They constitute dikes, stocks, and larger irregular bodies that may be called bathyliths, all Precambric in age though widely separated no doubt in the intervals of intrusion. The term "massive" is hardly applicable to their general field appearance since they often pass by insensible gradations from such condition into gneissoid and schistose phases, scarcely distinguishable from some of the country formations which are made up of an unresolved complex of gneisses and schists with the more characteristic members of the sedimentary or Grenville series, the latter including quartzose, mica and hornblende schists, amphibolites, graphite schists, quartzites and crystalline limestones.

The massive granites of this region have for the most part decided colors, ranging from pink to dark red in the different occurrences, while the very light and gray shades are relatively uncommon. They are generally rather coarse in grain, but finer sorts occur as local modifications of the coarse rocks or in separate intrusions. The predominant reddish color is imparted by the feldspar of which the prevailing variety is microcline. Hornblende and biotite (both

Plate 9

Glaciated knob of red granite on Carthage and Adirondack Railroad, near Jayville

are usually present) constitute the dark ingredients most in evidence, but magnetite plays a more important part in the composition than usual in such acid rocks.

These red granites are perhaps the most available resource in the way of quarry material for general construction purposes within the interior of the western Adirondacks. They have a very wide distribution, with their gneissoid modifications covering a considerable but as yet undetermined area. In many places they do not show the uniformity of appearance or other qualities essential to architectural stone, particularly where the intrusions are small and, in the case of the larger bodies, along the contact zones which are often marked by inclusions, segregations and pegmatitic injections. The best locations for quarries are found usually in the central part of the larger masses.

In southern St Lawrence and northern Lewis counties occurs an extensive and practically unbroken area of the granite which is traversed for several miles by the Carthage & Adirondack Railroad. This is one of the more accessible exposures in the region and is described at some length in the following pages as the Fine-Pitcairn granite. Smaller outcrops are so numerous that there is little object in giving them individual mention. The section about Gouverneur and eastward of there toward Edwards contains many isolated knobs, and the schistose rocks in that vicinity are seamed and injected by granite in a way suggestive of the existence of a great underlying body of that rock. At Natural Dam, just west of Gouverneur, a quarry has been recently opened in a small bosslike intrusion for the supply of road metal. The rock is a massive hornblende-biotite granite, but too variable in composition and texture to be workable for architectural purposes.

The syenite intrusions are of the usual Adirondack type, characterized mineralogically by the preponderance of feldspar which is normally of greenish to grayish green color, coarsely crystallized, and mainly the intergrowth of orthoclase and albite called microperthite. The feldspar constitutes up to 90 per cent of the entire mass. The dark minerals are pyroxene, hornblende and magnetite, of which the last named occurs rather abundantly for a rock of syenitic composition. Quartz is a very variable component. The prevailing dark color gives way to light shades of gray when the syenite has undergone granulation and recrystallization, and in some places to red which lends a certain similarity of appearance to the gneissoid granites. In such crushed phases there are always

unreduced remnants of feldspar scattered through the fine groundmass, as evidence of their derivation from an originally coarse-grained rock.

The principal area of the syenite, thus far noted, lies on the western border of the Fine-Pitcairn granite bathylith, and has been described in some detail by C. H. Smyth, jr. There are smaller scattered areas in other parts of the western Adirondacks. The syenite is not well adapted for building stone on account of its prevailing dark color; moreover its tough unyielding nature in the mass offers difficulties in the way of extraction and cutting that would make the cost rather high. Its chief application seems to be for crushed stone, for which purpose it is superior to the granite and compares very favorably with the best trap. As a monumental stone it does not appear to show nearly the density and fineness of grain that are found in the syenites of Clinton and Essex counties.

Gabbro is not very common in this section and the occurrences, in part at least, seem to represent a basic, pyroxenic variety of the syenite. The few areas that have been noted up to the present time are in remote sections. They require little consideration, therefore, from an economic standpoint, though they may prove of some value as sources of material for local highway construction.

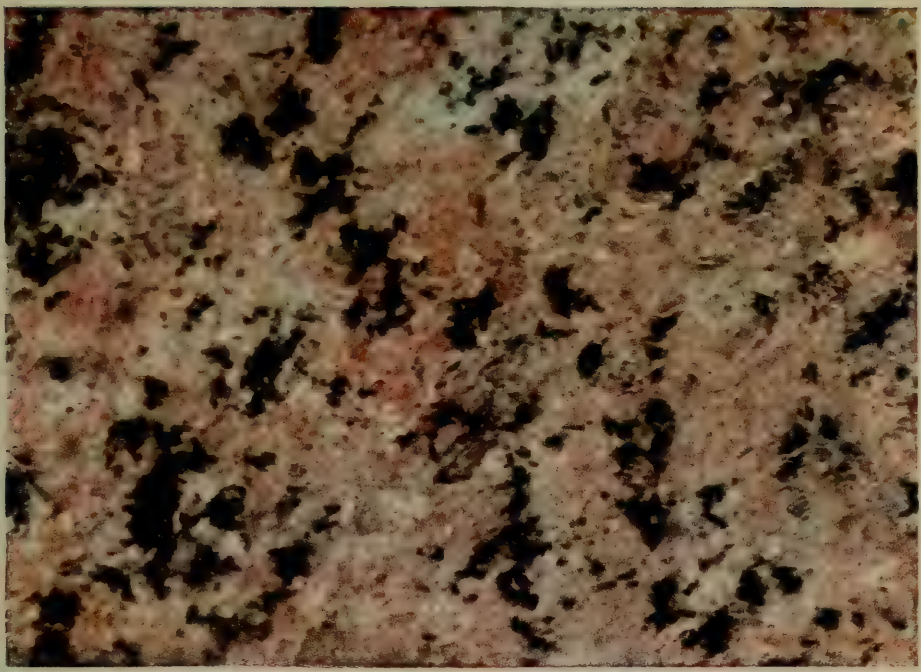
Trap dikes are likewise of minor importance, the recorded occurrences being few in number and of small size.

THE FINE-PITCAIRN GRANITE AREA

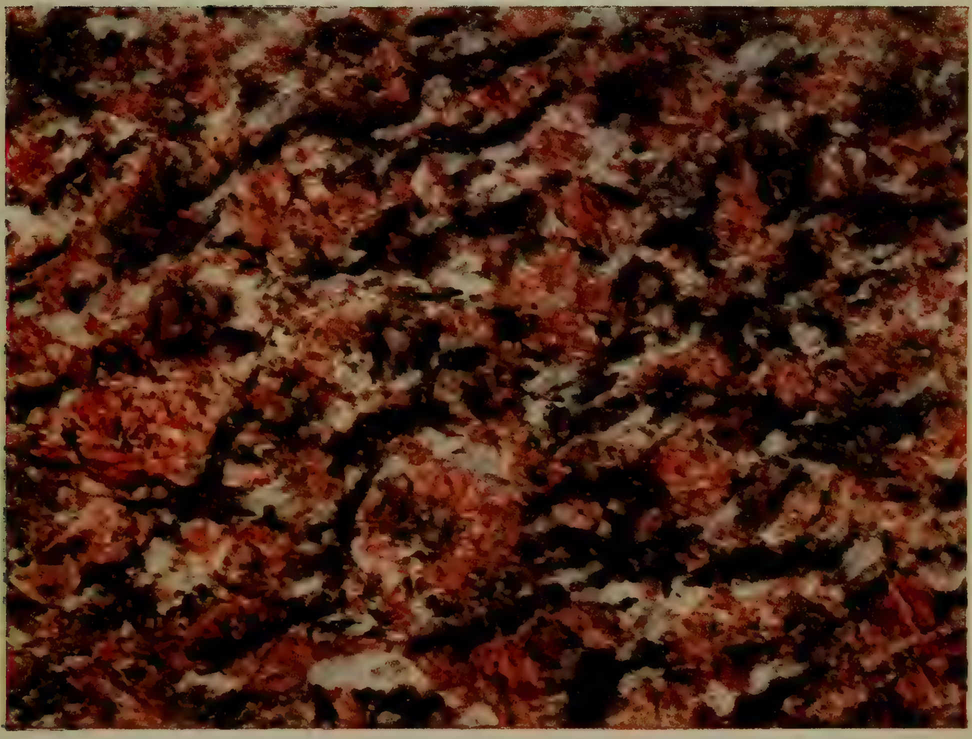
In the towns of Fine and Pitcairn, southern St Lawrence county, is an area of massive granite which, though not delimited as yet or shown on any of the published geological maps, must rank with the large granite exposures in the Adirondacks. By reason of its situation and adaptability to economic development this granite seems worthy of more than passing mention. So far apparently it has not been used for any purpose and its existence came to the writer's knowledge only through visits made several years since to the magnetic iron ore localities in its vicinity. The occurrence was revisited in the summer of 1911 when the section along the Carthage & Adirondack Railroad was examined with some care and samples taken for further study.

In places the granite possesses qualities as to physical structure, composition and appearance that seem to fulfil the requirements of a good architectural stone which could be employed very generally

Plate 10



Pink granite. Pine Island, Orange county



Red granite. Grindstone, St. Lawrence river

for foundation and construction work. Some variations, notably the coarse pink and white porphyritic phase, might find use for monumental stone. The convenient situation in regard to railroad facilities is an advantage not possessed by most of the localities where granite of similar character is exposed in the Adirondacks.

The section as measured along the winding route of the railroad extends about 8 miles in a general east and west direction. The first exposure on the west is near railroad milestone 56, which refers to Sacketts Harbor as the initial point, and the eastern border where the granite gives way to a well-foliated gneiss may be taken approximately at milestone 64, but is not sharply defined. The distance from Carthage, an important railroad center, is 25 miles, and from Watertown 40 miles.

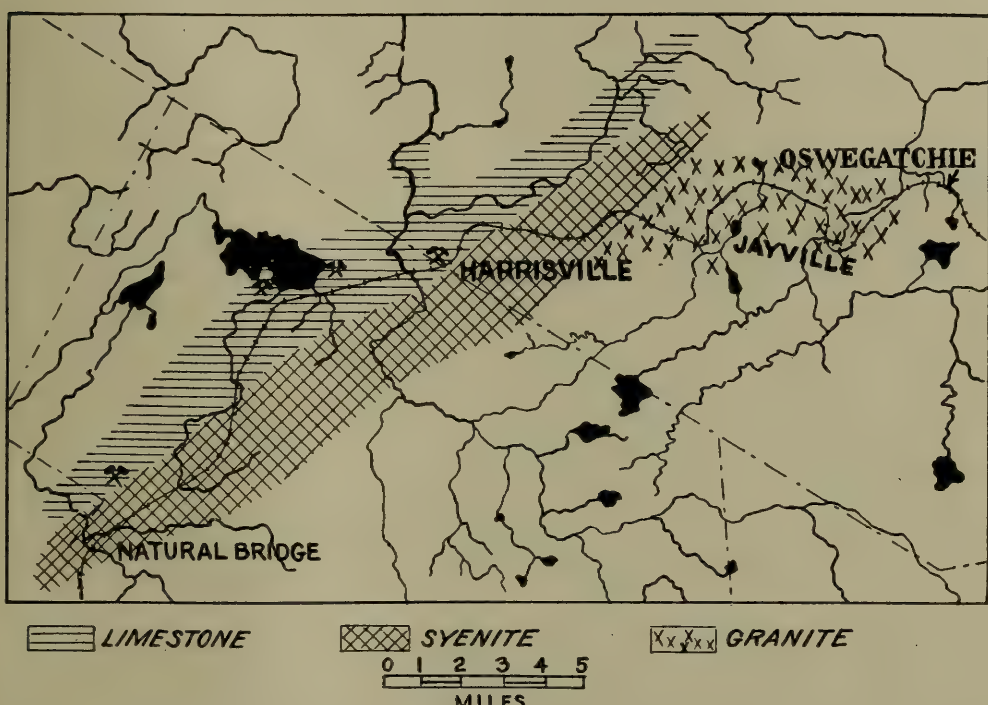


Fig. 7. Sketch map of the section along the Carthage and Adirondack Railroad from Natural Bridge to Oswegatchie

The exposures occur on both sides of the railroad in a series of ridges and hills that lend a rugged aspect to the topography though they seldom rise over 200 or 300 feet above the valley bottoms. They have no definite structural trend, in contrast with the regular north-east-south-west alignment of the ridges and valleys underlain by the older gneisses. The hills are more or less rounded, often hummocky on the summits, but there is little evidence of profound

glacial erosion. The ice apparently has performed most of its work in removing whatever weathered and disintegrated material may have accumulated on the surface in the long interval between its advent and the exposure of the granite to atmospheric agencies. Since the Glacial period the rock has hardly been affected by weathering; fresh unstained samples may be secured from the natural ledges. Over much of the area the hill slopes have been denuded of their former soil and drift covering, as the result of recent forest fires exposing the surface to rapid erosion, so that the granite nearly everywhere is well exposed.

On the western boundary the granite is in direct contact with the great syenite intrusion of the Diana-Pitcairn area that has been mapped and described by C. H. Smyth, jr. The contact where crossed by the railroad lies just west of milestone 56. The syenite here has a very basic composition, containing much magnetite and dark silicates, with a coarse texture. It is much like gabbro in appearance. The contact of the two intrusives is not clean-cut, sharply dividing one from the other, but over a considerable distance both granite and syenite occur in alternating seams and patches or as interlaced bands. In the hasty examination of this mixed zone nothing definite could be learned as to the time relations of the two intrusions. The granite, however, is in general the most massive. The stretch from contact to about milestone 57 on the western border consists of gneissoid granite with a marked parallelism in the arrangement of the light and dark minerals and rather finely granular texture. The ledges between milestones 57 and 60 reveal the granite in thoroughly massive or indistinctly gneissoid condition and rather coarse in grain. The color is red, pink or sometimes mottled by the appearance of white feldspar in addition to the colored variety. One phase seen near milestone 59 shows porphyritic red feldspar in white groundmass of feldspar and quartz, specked with black hornblende crystals. At Jayville, a former iron-mining locality, situated near the middle of the area, there appears a considerable body of black hornblende gneiss which seems to have been caught up by the granite on its way to the surface and is possibly a part of the older Grenville series. It is in this gneiss that the magnetite bodies are found. The next ledge beyond Jayville consists of the normal red granite which continues to milestone 61 where a white granular gneiss with rusty streaks outcrops for a short distance. These are the only large inclusions

Plate 11

Glaciated hummocks of red granite on line of Carthage and Adirondack Railroad, near Oswegatchie

noted within the section traversed. On the eastern border between milestones 62 and 64 the granite becomes finer in texture, evidently the result of granulation superinduced by pressure metamorphism, but maintains its normal composition and for the most part its massive habit.

With the exception of the two large bodies of gneiss that probably represent included masses of the older Grenville rocks, the area where traversed is quite bare of inclusions or contrasting material of all kinds. The most common variations are produced by segregated stringers of quartz and pegmatite, but these have a very limited development. In general, the granite shows much uniformity, the changes of texture or appearance taking place very gradually.

The ledges are intersected usually by widely spaced joints, of which the vertical ones are in two series crossing at high angles so as to produce heavy blocks. Dimension stone of any commercial size could be obtained in most of the ledges.

The extent of the outcrop along the railroad, the only part where a complete traverse has been made, indicates that the granite covers a very large area. It extends no doubt for considerable distances to the north and south. Exposures of red, somewhat gneissoid granite of similar character have been noted by the writer in the northern part of Fine township and in the Cranberry lake region. Smyth mentions the occurrence of red hornblende gneiss in northern Lewis county which he states shows massive phases at many places and resembles as a whole a slightly modified hornblende granite. This may represent the southern continuation of the area under consideration; at any rate it may belong to a common magmatic source.

Microscopic examination. A study of thin sections from samples taken at different places within the area shows the rock to belong to the hornblende-biotite granites, with the two dark minerals in about equal proportions or with the hornblende predominant. They are, however, of subordinate importance to the feldspars and quartz, and in composition the stone ranks with the acid class in which the silica amounts to 70 per cent or more, as is confirmed by the results of chemical analyses. The feldspar ingredients include microperthite and microcline which lend the reddish color to the mass and a variable but minor quantity of plagioclase, mostly oligoclase. Quartz is plentiful. In the more massive

types of the granite it occurs in rather large individuals having one or more crystal boundaries and to some extent as an intergrowth with the feldspar. Magnetite represents the principal iron ore, and no pyrite could be found in the sections. Apatite and zircon are among the accessory minerals.

The sample taken from the surface reveals little weathering or decomposition that is detrimental to the appearance and strength of the stone. There is no sap or iron stain in any amount and the effects of exposure to the elements are mainly noticeable in the clouded appearance of the feldspars and the conversion of a part of the ferromagnesian silicates into chlorite.

In regard to texture the granite shows considerable variation from place to place, though within narrower limits it maintains a degree of uniformity that makes possible the production of an even grade of material. The coarse phase is thoroughly massive, sometimes faintly gneissoid, and has a semiporphyritic appearance, with feldspars measuring from .5 to 1 inch diameter in a fine groundmass of feldspar, quartz, hornblende and mica. Another variety has an even granular texture, ranging from medium to coarse. Still other types show quite marked gneissoid and cataclastic textures as the result of pressure metamorphism, more apparent on the edges of the area.

Chemical analyses. The chemical composition of the granite is fairly exhibited in the following analyses made from the samples taken at different places along the line of the Carthage & Adirondack Railroad. They reveal the essential ingredients in their respective proportions, but do not give the less important ones like manganese, zirconium and phosphorus which have little or no influence upon the general character of the granite. The summary consequently falls somewhat short in each case of the full amount. The analyses were made by R. W. Jones, of the Museum staff.

	No. 1	No. 2	No. 3
SiO_2	75.01	72.69	70.03
Al_2O_3	12.88	14.11	13.12
Fe_2O_3	.02	.26	2.04
FeO	2.01	2.89	3.66
MgO	.41	.28	.74
CaO	1.10	.64	1.61
Na_2O	3.67	2.37	2.21
K_2O	4.16	5.16	4.14
H_2O+	.32	.24	.53
H_2O-	.08	.02	.06
	99.66	98.66	98.14

Plate 12

Porphyritic granite. Jayville, St Lawrence county

Sulphur was tested for, but not found. Analysis 1 represents the coarse massive granite from milestone 59. Analysis 2 is based on the finer grained massive rock from milestone 62. No. 3 relates to a sample taken from near the eastern edge of the area at milestone 64, which shows a strong cataclastic texture.

Physical tests. The following tests of the coarse and fine sorts of the granite from Jayville were made in the laboratories of the State Museum. The samples were taken from the natural outcrop.

Specific gravity	2.70	2.63
Weight, pounds a cubic foot	168.5	164.1
Ratio of absorption, per cent	.31	.264
Pore space	.99	.69

THE DIANA-PITCAIRN SYENITE

The syenite intrusion, previously mentioned as forming the western boundary of the red granite in southern St Lawrence county, needs only brief description in this place. It can not be considered to offer opportunity for the extraction of building materials on a large scale, though the massive phases of the rock are well adapted for highway and concrete material. The somber color which is generally characteristic of this rock in the Adirondack exposures is unsuited to most architectural purposes.

The syenite area is well shown on the large geological map of the State. Its boundaries were traced by C. H. Smyth, jr, who has also given a detailed account of its geological and petrographical features in his paper on "Crystalline Rocks of the Western Adirondack Region."[1] The intrusion extends in a northeast, southwest direction across the townships of Diana, Lewis county, and Pitcairn, St Lawrence county, for a distance in all of 20 miles. Its width is usually less than 5 miles and its area may be estimated at not less than 75 square miles. The Carthage & Adirondack Railroad, after passing out of the red granite near milestone 56, crosses the northern part of the syenite intrusion and enters the limestone belt on the west just beyond Harrisville. The railroad again follows the syenite for some distance in the stretch from Bonaparte lake to Natural Bridge, near the southern end of the intrusion.

The syenite is grayish green to dark green, heavy and very tough rock composed largely of feldspar but containing considerable

[1] N. Y. State Museum Report 51, v. 2, 1899.

amounts of the ferromagnesian minerals and magnetite. The coarser, massive phase, which may be regarded as the original type, is only occasionally observed in the field, for the whole mass seems to have undergone more or less granulation and recrystallization from pressure metamorphism. This circumstance indicates an earlier period of intrusion for the syenite as compared with the red granite of the same region, though the contact relations where observed did not afford any definite evidence in that particular.

Microscopic examination. The feldspar is principally a microperthitic intergrowth of orthoclase and albite, with a little acid plagioclase. In many places the feldspar constitutes over 80 per cent of the entire rock. A deep green pyroxene is usually observable in small, irregularly bounded individuals with which a darker hornblende is often associated in a manner suggestive of its derivation from the pyroxene. Quartz and magnetite are important accessory minerals, the former being particularly abundant in the more foliated varieties. Zircon and titanite also occur and the presence of a little pyrite may usually be observed.

Fig. 8. Microscopic appearance of syenite from near Harrisville. Shows groundmass of crushed feldspar, with larger fragments of the original crystals, also a little pyroxene and magnetite

The syenite often has a porphyritic appearance as the result of crushing which has reduced all but a small remnant of feldspar to a fine, granular aggregate. The texture is seldom perfectly massive.

Chemical analysis. The chemical character of the syenite is illustrated by the following analyses. No. 1 is of a sample taken from the eastern contact near milestone 56 on the Carthage &

Adirondack Railroad (R. W. Jones. analyst). No. 2 is quoted from Smyth's paper:

	No. 1	No. 2
SiO_2	63.11	65.65
Al_2O_3	18.02	16.84
Fe_2O_3	2.12	.....
FeO	3.53	4.01
MgO	1.43	.13
CaO	2.56	2.47
Na_2O	4.08	5.27
K_2O	4.26	5.04
H_2O+	.26	.30
$H_2O?$	.09	
	99.46	99.71

Sulphur is not shown, though present in small amount.

Physical tests. A sample of the syenite from milestone 55 Carthage & Adirondack Railroad, was tested in the laboratories of the State Department of Highways: Specific gravity, 2.705; weight, pounds a cubic foot, 169; absorption, pounds a cubic foot, .07; hardness, 18.1, toughness, 15. Tests by the writer showed ratio of absorption .148 per cent, pore space .402 per cent.

PARISHVILLE RED GRANITE

A monumental and structural granite has been quarried at Parishville in eastern St Lawrence county. It has a dark red fine-grained body in which appear curved and branching veinlets of bright red colors and somewhat coarser grain, but of the same mineral compositions as the rest. The veining is not sharply defined but shades off on the borders and in places develops into round or irregular nuclear patches which give the effect of clouds of lighter color. The appearance of polished surfaces is attractive as it is quite rare among stones of this class. The variation in grain is not the result of pegmatitic injection, but of different conditions of crystallization during a period of resoftening of the rock. The granite belongs to the Adirondacks granite gneisses and is composed of feldspar, biotite and quartz, the last in rather small amount, with some hornblende, magnetite and zircon and a little chlorite.

Crushing tests on the granite made at the Clarkson School of Technology at Potsdam showed an ultimate resistance of 20,000

pounds to the square inch. The chemical composition, as determined by L. K. Russell is as follows:

SiO_2	66.78
Al_2O_3	13.01
Fe_2O_3	6.50
MgO	.92
CaO	1.31
Na_2O, K_2O	10.89
H_2O	.51
Total	99.92

The quarry is owned by the St Regis Red Veined Granite Co., and the output thus far has been mainly monumental stock.

GRANITIC ROCKS IN THE EASTERN ADIRONDACKS

The eastern Adirondack region, or so much of the highland as is included in the Lake Champlain drainage area convenient to rail and water transportation, is made up largely of igneous rocks belonging to the class of anorthosite, gabbro, syenite and granite. Their intrusion took place in Precambric time before the final stages of uplift and metamorphism that profoundly modified the region during that period had been accomplished. Laminated gneissoid characters are very common; in fact there are comparatively few localities where the igneous rocks show unchanged, massive structure. The existence of unreduced or slightly modified residuals affords a basis for quarry operations in connection with building and monumental stone of the best quality, while there is an unlimited supply of material suited to many purposes for which absolute uniformity of texture or an attractive appearance is not essential.

Rocks of the anorthosite class are most widespread in this section of the Adirondacks. They have a very simple mineral composition, consisting almost wholly of basic plagioclase feldspar, usually labradorite and in their unaltered phase are characterized by very dark colors. The anorthosites spread over most of Essex county as a single, practically unbroken, area that embraces all the more prominent Adirondack peaks within its borders. They extend in force westward into Franklin county, but have little representation in Clinton county, the southern border of which is nearly coincident with the northern limits of the main area. An outlying intrusion of small compass occurs, however, in Beekmantown and Altona townships of Clinton county about 20 miles north of the county line.

Plate 13

The Moore syenite quarry, Ausable Forks

In their typical development the anorthosites are too coarse in texture and too dark in color to find favor as building materials. Much of the interior part of the area is made up of this very coarse type. Along the borders they are usually finely textured owing to secondary crushing, and their color then becomes lighter if not influenced by an abnormal proportion of iron-bearing minerals. Some variations of this border phase present a uniform, even granular appearance, closely resembling in mass a true granite with which the anorthosite compares favorably as regards durability and strength.

Few quarries have been opened in the anorthosite and these are situated in the northeastern part which is most accessible to the lake. Old quarry sites exist on Splitrock mountain between Westport and Essex village and near Keeseville. Some work has been done, also, on the small outlier in Beekmantown and Altona townships, Clinton county. More recently attention has been given to the locality near Ausable Forks, where there is an area underlain by uniform light-colored anorthosite.

The syenites and granites of this section are found in smaller intrusions in the midst of gneisses which surround the anorthosite. Both classes show a tendency toward laminated structures and on that account have limited quarry possibilities. The syenite is dark green, while the granite is mostly a red variety. A local development of massive syenite that occurs at Ausable Forks on the border of the anorthosite, has recently come into prominence as a source of monumental stone. The red granite has been quarried only to a small extent.

The gabbros have little importance economically except as possible sources of supply of road metal for which the massive types would appear to be excellently adapted by reason of their usually tough, firm nature. They form small intrusive knobs in the gneisses and also are found quite commonly in the anorthosite area.

In this connection mention may be made of the diabase dikes which occur all over the region, and are particularly abundant in southern Clinton county. Like the other igneous rocks that have been mentioned they are of Precambric age, though they show no effects of pressure metamorphism and must have been intruded in very late Precambric time. They seldom attain a workable size, the average thickness being not more than 10 or 15 feet. For road-making they offer the best material to be had anywhere, but so far no very accessible dikes of large size have been found.

AUSABLE FORKS SYENITE AREA

The vicinity of Ausable Forks, about 15 miles west of Lake Champlain and 24 miles by rail southwest of Plattsburg, presents many advantages for quarry operations in connection with both anorthosite and syenite. For several years past a considerable quantity of monumental stone has been shipped from this section and recently additional developments with a view to the extraction of building stone in a large way, as well as monumental stock, have been planned.

The main anorthosite intrusion of the central Adirondacks extends from the south to within a short distance of the confluence of the east and west branches of the Ausable river, where the village is

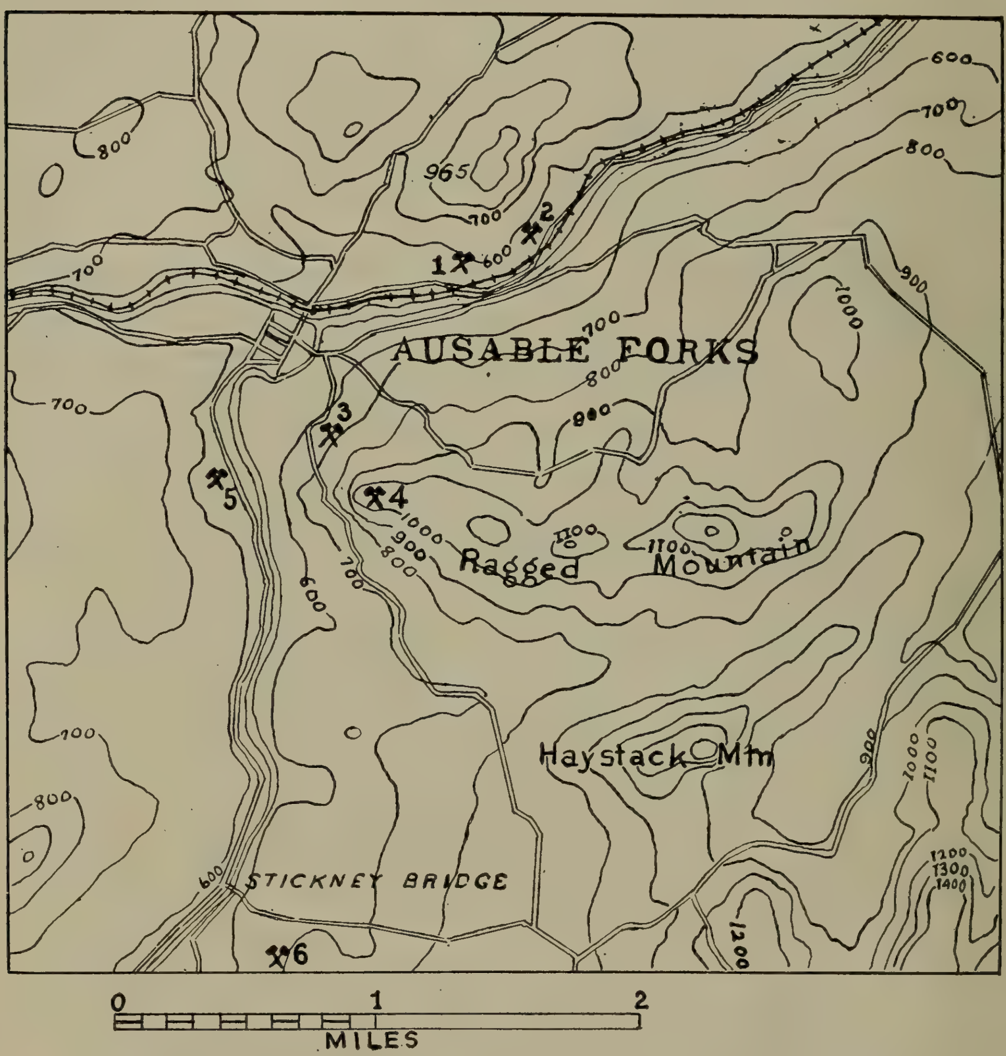


Fig. 9 Map of the quarry section about Ausable Forks. 1–5 are quarries in green syenite; 6 is anorthosite quarry

Plate 14

Part of the Moore syenite quarry, Ausable Forks

situated. The rock outcrops in a series of low hills and ridges which are mostly bare of soil and afford natural quarry sites. It is of medium to light gray color as seen in exposures, or in rough dressed surfaces, about the equivalent of a gray granite, for which it serves well as a general building material. The anorthosite belongs, of course, to the border phase of the intrusion, characterized by a granulated feldspar ground mass with rather more than the usual percentage of dark silicates.

The syenite which is quarried principally for monumental purposes occupies an area between the anorthosite on the south and the red gneisses that extend over most of the county immediately north of the Ausable river. It outcrops in the first ridges just north of the village, and also on the west side of Ragged mountain on the south bank and in the triangle formed by the two forks of the Ausable. The different exposures belong very likely to a single boss of the syenite which has forced itself up along the gneiss-anorthosite contact. The rock is of medium grain, massive. In color it varies from dark to very dark green as seen on rock face and polished surfaces, but grayish green on hammered work. Its perfect polishing qualities and ability to take the finest tracing which it shows in strong relief, combine to make it one of the most attractive monumental stones on the market.

The Moore quarry

The syenite quarries are located on both sides of the river. Those on the north side are situated along the ridge that lies a little distance from the town and north of the railroad. The Moore quarry is near the base of the ridge which rises steeply at first so as to afford a good working face of 100 feet or more, and then more gradually to the summit which is over 400 feet above the railroad. There is practically no soil covering on the rock and weathering has produced no more than a slightly bleached layer, which at a few inches depth passes into the normal rock. No sap or stain is apparent. The rock is broken into large blocks by two vertical joint courses running N. 40° E. and N. 50° W. An inclined course cuts across these in a direction N. 20° W. and dips 45° northeast, in conformity with the surface slope, giving the effect of a sheeted structure. The rock is said to split easiest in a direction parallel to the inclined joint systems. Several trap dikes from 10 inches to 2 feet thick intersect the ledge in a northeast-southwest direction. They have exerted little contact effect upon the syenite and in some respects are an advantage to the quarry

work, as they form a natural back from which the rock may be broken away.

The syenite is medium to fine in texture, the feldspar which composes the greater part of the mass ranging from 5 mm down to 2 mm in diameter. The color in the quarry is bright green to yellowish green, and of polished surfaces a lustrous dark green that appears nearly black when seen from a distance. The stone from this quarry is sold under the name of "Adirondack green granite."

The quarry was first opened by Moore Brothers of Barre, Vt. It was later taken over by the Adirondack Granite Co., a consolidation of several quarry properties in the vicinity of Ausable Forks. Recently it has been worked under lease by J. H. Moore.

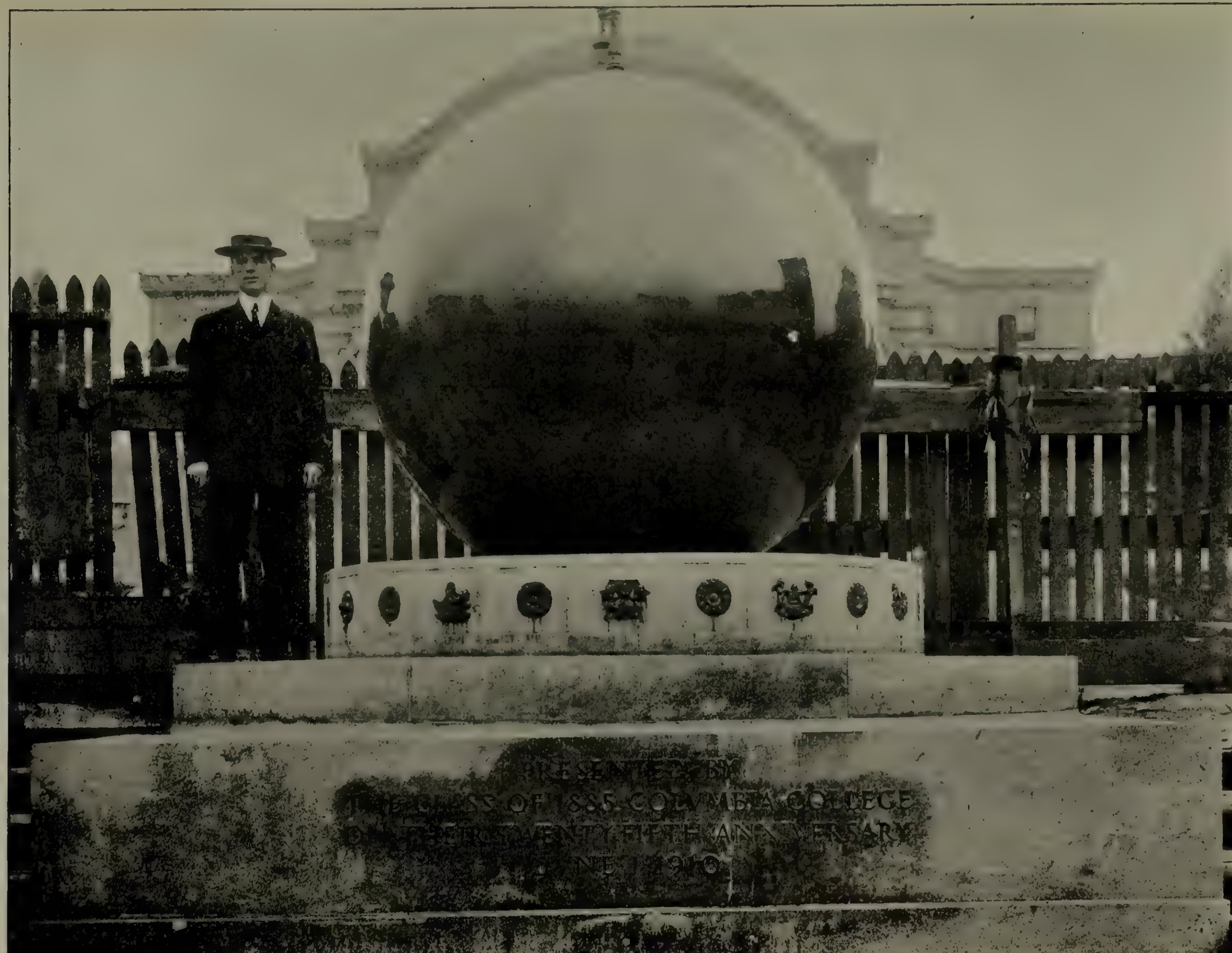
Microscopic examination. The composition of the syenite is about 75 per cent of feldspar and 25 per cent of other ingredients, including pyroxene, quartz, magnetite and zircon. The feldspar consists of microcline, microperthite and oligoclase, all in stout prisms with interlocking borders. The microperthite is very abundant and affords beautiful examples of this peculiar intergrowth, the alternating bands of microcline and albite being unusually large. The pyroxene has an emerald green color and is strongly pleochroic. Zircon is quite abundant. There is very little evidence of alteration among the minerals, but some secondary limonite has been deposited along the sutures and pores, probably filtering in from the surface. The feldspar and quartz are crossed by microscopic fractures in the direction of the grain similar to those found in granites, but smaller in dimensions and less abundant. No sulphides were observed in the sections.

Physical tests. The syenite from this quarry has a specific gravity of 2.71, or a weight of 169 pounds to the cubic foot. The crushing strength is 14,734 pounds a square inch. The ratio of absorption is .155 per cent or .26 pounds to the cubic foot.

Ausable Granite Company's quarry

The first syenite in the Ausable Forks area was quarried from the ridge a little east of the Moore quarry by the Ausable Granite Company, later consolidated with the Adirondack company. The quarry has not been operated for the last few years, as the other localities offer better advantages for extracting stone of uniform grade. The general character of the rock, however, is very similar to the material in the Moore quarry. The quarry supplied both monumental and building stock in limited quantity.

Plate 15



Polished sphere of green syenite, quarried by the Adirondack Granite Company at Ausable Forks. The sphere is 7 feet in diameter and weighs approximately 16 tons, the original block from the quarry having weighed 39 tons.

The Charles Clements quarry

The Charles Clements quarry is situated south of the Ausable on the shoulder of Ragged mountain, overlooking the village of Ausable Forks. It yields a fine-grained syenite of darker color than that from north of the river, though it is no doubt a part of the same intrusion. The quarry is opened as a pit and thus is worked to some disadvantage, though the depth is not sufficient as yet to complicate the operations. The quarry belongs to Charles Clements, a dealer in monumental stone, of Boston, who has shipped the product in the rough.

Microscopically, the syenite in the area south of the river differs considerably from the type described under the Moore quarry. The syenite here is evidently a border phase of the intrusive mass, characterized by fine grain, and a larger percentage of the dark constituents, with reaction minerals like garnet. Owing to its fine texture, it splits with a smooth or conchoidal fracture like a trap. Along with the increase of the ferromagnesian minerals there is a gain also in lime-soda feldspar which shares importance with the alkali varieties. It is a basic phase of the syenite which in other places in the Adirondacks may be observed to grade over into a gabbro.

The texture of the rock is even-grained, massive, showing no trace of the gneissoid arrangement that often accompanies the basic gradations. The jointing is at wide intervals and almost any size of block can be quarried. There is no well-developed sheet structure, but a series of unequally spaced bed joints is present.

The Carnes quarries

The Carnes quarries, owned by F. G. Carnes of West Chazy, are situated about one-half of a mile south of Ausable Forks on the western continuation of the Ragged mountain exposure. They are not as yet developed for supplying large quantities of stock, but have been opened sufficiently to prove that there is material of good quality. One quarry, called the Keystone, lies at the base of the mountain, between the highway and the river. It yields a green syenite of lighter shade than that from higher up the mountain. The quarry lands in this location cover 35 acres.

On the opposite side of the East branch the syenite appears again along the slopes of a low ridge that is partly covered with terraced sand deposits. The Emerald quarry is situated in this exposure. The ledge affords a face from 15 to 25 feet high and about 400 feet long. There is in all 300 acres in the property. The syenite is

intersected by widely spaced block joints. It is a dark green rock of fine texture. It takes an excellent polish and is well suited for monumental stone.

Under the microscope the syenite from the latter quarry presents some peculiarities not noted in the other occurrences. The chief feature is connected with the ferromagnesian minerals which consist mainly of a dark hornblende in the place of the usual green diopside, and a smaller proportion of an orthorhombic pyroxene that corresponds to hypersthene. Quartz is more abundant than usual for syenite, occurring in small grains on the borders and in the interior of the feldspars. The latter comprise microperthite, microcline and oligoclase. The accessory constituents include magnetite, zircon, apatite and titanite. The secondary products of alteration are mostly chlorite, which is observed on the borders of the hornblende, and limonite. The texture is even-granular massive.

AUSABLE FORKS ANORTHOSITE AREA

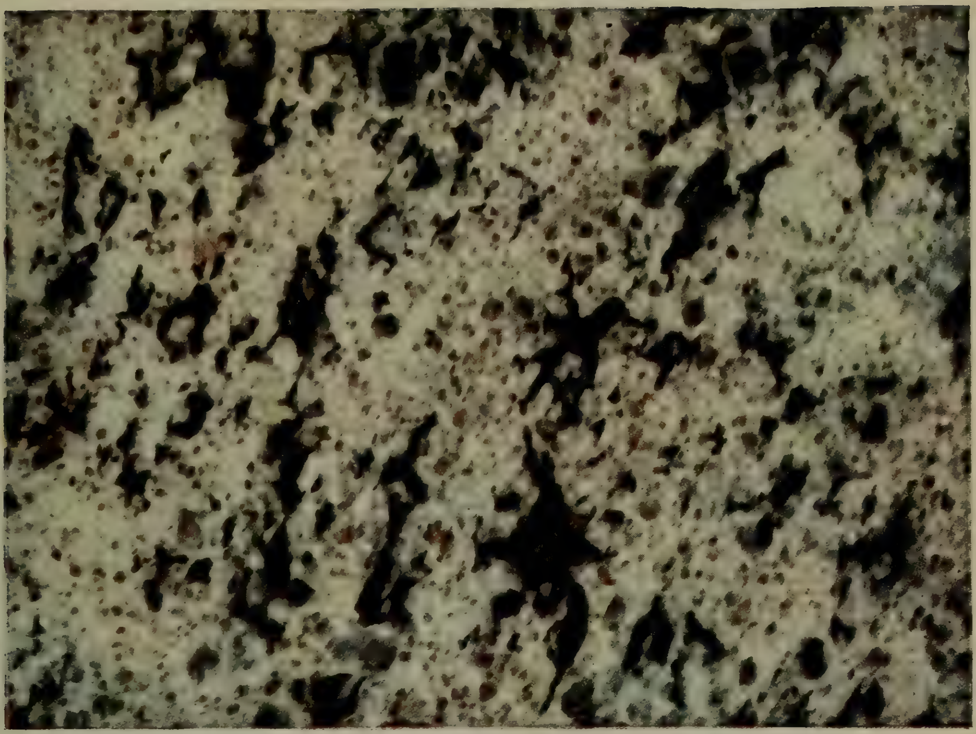
In the last few years some attention has been given to the quarrying of anorthosite for building and monumental stone in the vicinity of Ausable Forks. The anorthosite outcrops on the road from Ausable Forks to Jay, beginning just south of the Stickney bridge along the ridges that limit the valley on either side.

The anorthosite belongs to the granulated type in which the originally coarse feldspar crystals are only now and then evidenced by unmashed individuals which in their surroundings of fine-grained material appear like the phenocrysts in a porphyry. The color is gray of light or medium tone while the uncrushed feldspars have a dark greenish or bluish appearance and an iridescent play of color. Some types contain much pyroxene, which is black in the hand specimen; the stone then is similar in appearance to a medium-grained or coarse-grained granite.

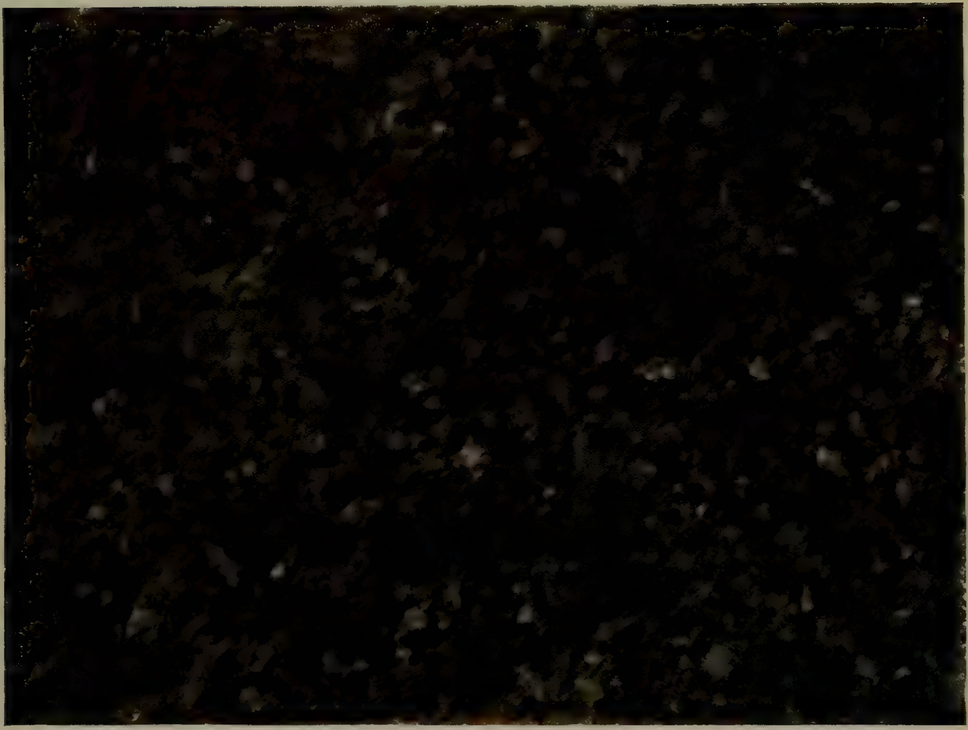
Most of the stone has been shipped from a quarry situated one-half of a mile southeast of the Stickney bridge, formerly worked by the Adirondack Granite Co. It is a small opening with a face about 20 feet high, but the ledge extends fully 500 feet with a face 50 feet high. The stone from this quarry was used in the two first stories of the Locomotive Engineers Building in Cleveland, Ohio, and in the Adirondack National Bank Building at Saranac Lake.

The rock is traversed at rather wide intervals by two sets of vertical joints running N. 50° W. and N. 35° E. respectively. There is a less marked division in a plane inclined about 30° from the

Plate 16



Gray granite (Anorthosite). Ausable Forks



Green syenite. Ausable Forks

horizontal. It possesses a marked rift and grain structure which follows the direction of the vertical joint systems and which has already been described in the earlier discussion of that structure. Blocks of any merchantable size can be quarried: one containing about 6000 cubic feet was exposed in the course of operations in 1911.

The same character of rock extends eastward from this opening on to the Loren Williams place, between the North Jay and Stickney Bridge roads, where there is a very extensive exposure and the outcrop is found on the sides and top of the knob next south of the quarry opening, but the rock here has a coarser texture with a larger proportion of uncrushed feldspar.

Microscopic examination. Thin sections of the anorthosite examined under the microscope reveal its simple mineral character. It is mainly feldspar of one kind, a basic plagioclase corresponding to labradorite in optical properties. The individuals have been broken down to small grains 2 or 3 mm in diameter, which are interlocked, however, as thoroughly as the components of any granite. Effects of compression are also evidenced by strain shadows in the larger residual crystals. The feldspar shows some alteration to mica around the borders, but otherwise is fresh. The dark constituents are hornblende and pyroxene, frequently intergrown and showing irregular boundaries. There is a little magnetite or ilmenite in fine particles, but no pyrite.

Physical tests. The results of physical tests indicate that the anorthosite meets all practical requirements for a building stone. The crushing strength measured on a tube tooled down but not polished was 14,735 pounds a square inch, or equal to that of an average granite. The specific gravity is 2.75, or a little heavier than granite, corresponding to a weight of 172 pounds to the cubic foot. The absorption is low, with a ratio of .127 per cent. The hardness, according to the tests of the bureau of research, State Department of Highways, is 17.6 and the toughness 6. Another sample of anorthosite from Ausable Forks, locality unspecified, showed the following results: specific gravity 2.74; abrasion (French coefficient) 10.5; hardness 18.7; toughness 10.

Red granite, Ausable Forks

An outcrop of granite on the Clintonville road 2 miles east of Ausable Forks has afforded a limited quantity of monumental stone of which some has been used locally and the rest shipped to

dealers. The rock is an interesting type, as it belongs to the true granites, being composed of feldspar and quartz in normal proportions, but on the other hand contains no dark silicates of the mica, amphibole or pyroxene families. In the place of such minerals, however, it carries a large amount of magnetite which ordinarily is a very minor constituent of granite. This mineral constitutes about 15 per cent of the entire rock, its relative abundance more than compensating for the absence of iron-magnesia silicates in effect upon the specific gravity. The latter is 2.8 which corresponds to a weight of 175 pounds to the cubic foot, which is very high for granite. The color is purplish brown to dark red. The grain is regular and fine, the average diameter of the quartz and feldspar grains being under 2 mm. The appearance of the polished surfaces is attractive.

The quarry is a small opening with a face of about 12 feet. It is on property owned by Mrs Beane of Ausable Forks.

THE KEESEVILLE ANORTHOSITE AREA

The anorthosite exposures in the vicinity of Keeseville near Lake Champlain, have been the source of fairly large quantities of building and monumental material. The rock is mostly the light, granulated variety that characterizes the peripheral zone of the great Adirondack mass. The stone has been sold under the name of Ausable granite.

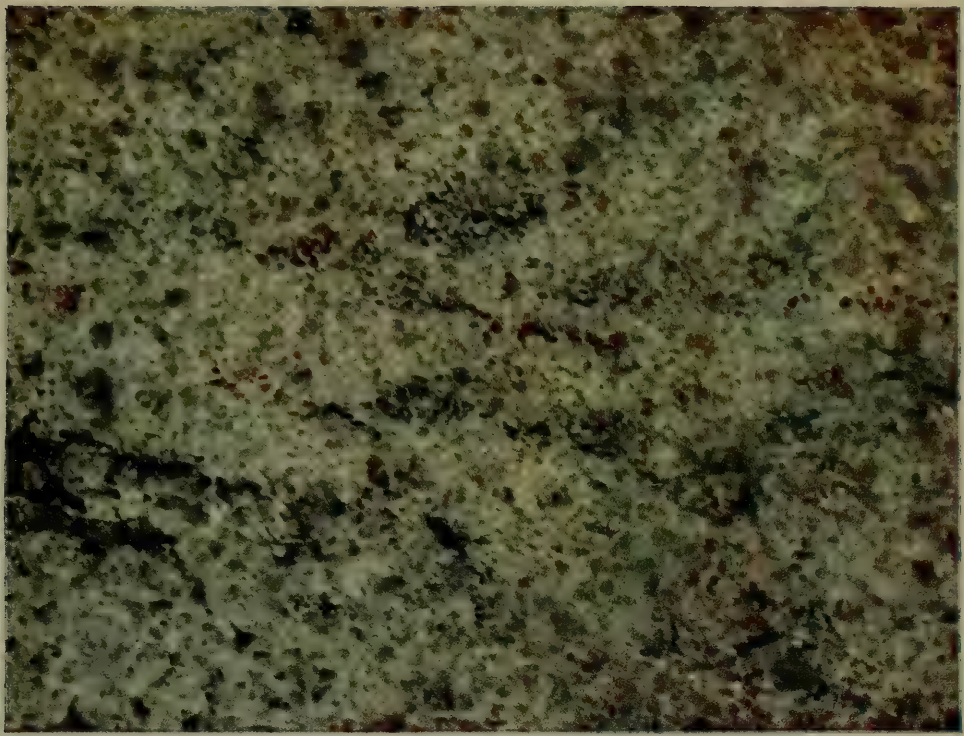
Prospect Hill quarries

The Prospect Hill quarries are situated on the northern and western slopes of that prominence, a rounded knob 300 feet or more high, lying just south of Keeseville. The northerly quarries once belonged to the Ausable Granite Co., and are mentioned by Smock as in active operation at the time of his investigation in the period 1880–90. The company also operated a dressing and monumental works at Keeseville.

The stone of these quarries is medium to coarse in texture, depending on the relative proportion of the granulated and residual uncrushed feldspar, and has a gray color. The rock surfaces show glacial striations and polishing, but are almost unaffected by weathering influences.

Smock describes two quarries as operative, a lower one to the north producing a coarse variety, and an upper quarry about 20 rods south of the former and higher up the hill, each equipped with a single derrick. The quarrying of dimension stone must have been

Plate 17



Gray granite (Anorthosite). Keeseville

Green granite (Anorthosite). Keeseville

expensive, as the jointing is irregular in regard to direction and spacing. The principal uses of the stone appear to have been in monumental and decorative work. It was employed in the trimmings of the Y. M. C. A. building in Burlington, and also in the interior decoration of a Philadelphia church, but had the widest sale for monuments, of which there are many specimens in the cemeteries of that vicinity. A local example of its use in buildings is found in the French Catholic church at Keeseville, which, however, was constructed mainly of the quarry waste. At the time the quarries were worked, the branch railroad from Port Kent to Keeseville had not been built and all the stone had to be hauled to the lakeside by teams.

G. P. Merrill in his "Stones for Building and Decoration" speaks of the Keeseville stone as "admirably adapted for polished columns, pilasters, and other decorative work." But he also remarks that the material in some places shows minute fractures which may prove detrimental to its weathering qualities.

Physical tests. The stone is credited by Smock with a crushing strength of 29,000 pounds to the square inch, which is higher than the average. The specific gravity is around 2.75, indicating a weight of 175 pounds to the cubic foot. Ratio of absorption, .066 per cent.

Empire State Granite Company's quarries

The Empire State Granite Co. has been engaged recently in the development of quarry lands to the west of Keeseville, near the Clintonville road, on property owned by George W. Smith of Keeseville. The company has also an area on the west side of Augur lake which it has prospected to some extent.

The anorthosite in this section shows more uniformity of character than that on Prospect hill and its structural features are better adapted for quarry operations. It is traversed usually by two series of vertical joints crossing at right angles. A horizontal series is also present. It splits readily with plug and feathers in two directions which correspond to rift and grain in granite. Dimension stone and paving blocks can be quarried without more difficulty probably than with ordinary granites. The joints show very little sap and the stone is practically fresh from the surface.

Two openings have been made on the Smith property west of Keeseville. At the more westerly one the anorthosite forms a ridge with a nearly vertical rise on the north of about 50 feet. This is

being developed as a side-hill quarry. The fractured surface of the rock has a light green color with occasional mottlings of dark green to black caused by uncrushed remnants of the feldspar. The polished surface appears sea-green with the same mottling, but showing also more or less the iridescence peculiar to labradorite. Close inspection reveals fine specks and threads made up of red garnet. A 12-foot diabase dike intersects the ledge in an east-west direction.

The second quarry, 1000 feet northeast from the former, is a pit which at the time of the writer's visits was about 20 feet deep. The stone is much coarser with more of the residual feldspar crystals distributed through the mass. The jointing is in two directions — northeast and northwest — with a horizontal series from 3 to 4 feet apart. Along two of the northeasterly joint seams have been intruded dikes of trap and syenite porphyry, the former 3 inches and the latter 18 inches wide.

The anorthosite is exposed on the west shores of Augur lake in a series of cliffs from 75 to 100 feet high. The sides of the cliffs have been exposed directly to the weather ever since the glacial period at least, yet the weathered stone is only a fraction of an inch thick. This seems to indicate good resisting powers to frost and agencies of decomposition. The jointing is very heavy, the intervals often being 8 or 10 feet. Some of the rock contains biotite in the place of the usual pyroxene.

Microscopic examination. The general run of the stone from the different localities may be described as composed of labradorite in large part, the average being from 75 to 85 per cent. On account of the frequent residual feldspar crystals, the grain would be called coarse, although the groundmass itself is fine grained. The larger feldspars are from 10 to 20 mm in diameter, with occasional individuals still larger. The principal dark mineral is diopside, which appears emerald green in thin sections. Hornblende and biotite are locally developed and take the place of the pyroxene. Garnet is nearly always present in aggregates of small grains arranged about the pyroxene, from which it has no doubt been derived in the metamorphic process. Ilmenite is in small amount and an occasional speck of pyrite can be seen. The decomposition products are kaolin from the feldspar and chlorite from the ferromagnesian minerals. They are not in sufficient amount to cause any noticeable weakening of the structure.

Physical tests. Specimens of the anorthosite were tested by the office of public roads, United States Department of Agriculture, at

Washington with the following results, no. 1 referring to the stone from the Smith property and no. 2 to that at Augur lake.

	No. 1	No. 2
Crushing strength, pounds a square inch	20,500	18,500
Specific gravity	2.75	2.70
Weight, pounds a cubic foot	172	168
Water absorbed, pounds a cubic foot	.51	.49
Wear (French coefficient)	11.7	10.4
Hardness	18	18
Toughness	13	10

The physical tests indicate that the material meets all the ordinary requirements of building material. There can be little doubt as to its durability under weathering conditions, though it has not been proved by actual service in buildings. For polished work it should also prove acceptable on account of its rare color. The only drawback to that use seems to be the presence in some of the polished specimens of minute hairlike fractures visible on close inspection. These are the more apparent by reason of the translucent background, but as evidenced by the crushing strength and absorption do not materially weaken the general structure.

Quarry of C. B. White, Augur lake

Along the west side of Augur lake anorthosite outcrops over a large area, forming a broad ridge which breaks off at the lakeside in a line of perpendicular cliffs 100 feet high. It is mostly a light-colored labradorite rock, of medium grain, in general appearance not unlike gray granite. It contains scattered crystals of pyroxene and occasionally some biotite. In places these minerals become sufficiently abundant to give a rather dark tone to the rock surface, but generally they are of subordinate importance. The minor accessory constituents are garnet, ilmenite and a little chlorite and kaolin from decomposition. The anorthosite is undoubtedly a good durable building stone.

The property owned by Mr White includes a quarry opening which lies on top of the ridge above the lake. The quarry was last worked in 1892; the product was employed in the construction of the Criminal Courts Building in New York City. A large quantity of rough stone, much of it suitable for dimension stone, was left in the quarry. The principal drawback to operations is the long haulage to the railroad, the nearest shipping point being Keeseville, the terminus of a short branch railroad that connects with the Delaware and Hudson line at Port Kent. The quarry is about 5 miles in a direct line from the shore of Lake Champlain.

THE SPLIT ROCK ANORTHOSITE AREA

The great anorthosite intrusion of the central Adirondacks has its most easterly exposure on Split Rock mountain, the bold ridge that forms the western shore of Lake Champlain for several miles, beginning just north of Westport. The whole mountain is practically made up of this rock and its gabbroic type, though on the north end it gives way in places to the Grenville series of limestones and schists which have been surrounded and borne up apparently by the igneous mass. The darker phase of the anorthosite is mainly in evidence in the exposures along the lake and on the north end. The bulk consists of the grayish feldspathic variety which has been more or less comminuted by regional compression. In some parts of the mountain the rock has a distinctly porphyritic appearance by reason of the large residual feldspar crystals, but again it shows a local development that is characterized by uniformity of grain.

The only quarry workings in this exposure that are known to the writer are on the eastern face of the mountain, about one-fourth of a mile back from the lake and at an elevation of from 500 to 600 feet. They are reached by a trail from the Westport road and also from the lake by following the old tramway line that was used to lower the stone. The locality is just north of the little bay called Barn Rock harbor on the United States geological sheet, but is mentioned as Barron Rock in Smock's report of 1888. According to the latter, the quarries were first opened in 1881 by the Champlain Granite and Marble Co., and reopened in 1887 by the Adirondack Granite Co. Under the latter company, as the writer has been informed, a quantity of building and monumental stone was shipped, some of the building material having been sent to New York City. By 1890 the quarries were again closed and have not been worked since.

General characters. The stone from the quarry site has a grayish body with porphyritic feldspar of somewhat darker color. It is practically all feldspar, belonging to the very basic plagioclase series. Small, scattered crystals of pyroxene (diopside), magnetite and quartz occur in the interstices of the feldspar aggregate. The magnetite shows slight decomposition to hematite, but there is little pyrite, judging from the samples that were examined.

DANNEMORA GRANITE AREA

A gneiss of massive granitic appearance, pink or gray in color, outcrops on the ridge north of Dannemora, Clinton county. The exposure is a part of the larger belt of granitic and syenitic gneisses

which are developed extensively in the northern Adirondacks and are included in the Saranac formation of Cushing. In places the gneisses lose their usual foliated structure and when free of admixture with other contrasting gneisses are well suited for building and engineering materials. They contain a predominant proportion of the feldspar minerals, with moderate to small amounts of quartz and little of the dark silicates in the form of hornblende and diopside. Magnetite is a variable constituent, ranging up to 7 or 8 per cent in amount. The texture is fine and compact, the result of crushing and to some extent of recrystallization of coarse originals.

The principal quarries in this area are situated on the ridge back of the State Prison and Hospital grounds; they have been worked for the supply of building stone for these structures and to some extent for other purposes. They belong to the firm of Allen & Cunningham who have operated them under the name of the Dannemora Granite Co.

There are two openings situated less than a mile from Dannemora and from 300 to 400 feet above it. The more northerly one shows a pink gneiss of fine grain, containing magnetite as the principal dark ingredient, with more or less hornblende. There are occasional bunches of the dark minerals and also bands of pegmatite. The rock is jointed fairly regularly by two vertical veins running north-south and east-west respectively. Two trap dikes cut the granite just south of the quarry. The rock face is about 20 feet high. At the second opening the granite has a similar character and shows pegmatitic and dark-colored inclusions. A 4-foot trap dike intersects the quarry face in an east-west direction. The face is 100 feet long and 30 feet high. Jointing is prominent in two directions as at the first quarry. The streaks and inclusions are the main handicap to the working of the quarry for building purposes, although by selection a good quality of material can be obtained.

GRANITE IN THE TOWN OF WILTON, SARATOGA COUNTY

A massive gray granite is found in the town of Wilton, Saratoga county, about 2 miles north of Saratoga Springs. It outcrops on the easterly-facing ridge which marks the first elevations of the Precambric highland of the Adirondacks to the west of the Paleozoic plain. The area is of unknown extent but to the north the granite soon disappears, being succeeded by Grenville schists and quartzites with bands of crystalline limestone. The granite has a fine granular texture, the result probably of crushing of a much

coarser rock under pressure metamorphism. There is evidence of the original coarse grain in occasional fragments of feldspar and quartz which have escaped the general reduction. In its appearance and physical characters it resembles the earlier series of Adirondack granites, but does not show their well-defined laminated structure owing to the small proportion of dark minerals.

The granite was quarried quite actively at one time, and the old quarry face is still conspicuous as a white patch on the face of the ridge. The quarry property is owned by Henry McGurk of Saratoga Springs by whom it was last worked about twenty years ago. It was operated mainly for paving blocks which were used in the streets of Albany and Brooklyn, but some building material was sold of which a specimen structure may be seen in the Hathorn vault in Saratoga Springs.

The quarry face lies about 80 feet above the base of the ridge and is 100 feet long. The stone has been quarried back for 60 feet or more. Apparently the granite was shot down in large masses which were then broken up and trimmed into paving blocks on the spot. A large amount of waste had accumulated on the quarry floor to the obstruction of the progress of development. The rock is traversed by two series of joints of which the more prominent has a course about N. 25° E. dipping 80° northwest, and the other about N. 60° W. with a dip of 80° northeast. There is also a series of division planes inclining about 40° to the south, parallel to which a faint lamination can be seen in the granite owing to parallel orientation of the biotite scales. It is said to have a good rift and grain so as to dress readily with even surfaces. Small bands of lighter granite are intercalated parallel with the lamination in parts of the quarry, and occasional knots or segregations of pegmatite and vein quartz are observable. There is, however, a good proportion of uniform material that could be used for building stone.

The granite is medium gray with very little of the dark silicates, which are limited mainly to biotite. Garnet in the form of grains and aggregates of grains up to an inch across is a subordinate but rather conspicuous constituent. The texture is compact, and the particles of quartz and feldspars average between 1 and 2 mm in diameter, the rock thus belonging to the fine-grained granites.

Microscopic examination. The feldspar consists of orthoclase, microcline and oligoclase, all of which show some alteration to sericite which impairs the quality of hardness. The particles are broken and angular and show strain shadows, evidencing the intense compression the rock has undergone. The quartz fills in the

interspaces and is also granulated. The biotite occurs in small scales, which here and there have been converted into chlorite. Iron ores occur very sparingly. The granite may be considered as a fair material for crushed stone or paving blocks and well adapted for all foundation work.

GRANITE AT HORICON, WARREN COUNTY

An occurrence of granite at Horicon, on the outlet of Brant lake, Warren county, has supplied some building stone in an experimental way. It has not attracted much attention for commercial quarry purposes, owing to its remoteness from the railroad and difficulties of getting the material into the market. The present interest is mainly connected with the rather unusual nature of the rock which differs from that of normal granites.

The rock has a porphyritic appearance owing to the presence of pink feldspars, which measure up to an inch long and are rather thickly distributed through a groundmass of dark gray color which is composed of greenish feldspar, quartz and biotite. The large feldspars give an attractive pattern and a warm tone to the polished surface. They belong to the microcline variety and are developed in stout prisms that are usually twinned and occasionally granulated and squeezed into lenticular form. The greenish feldspar of the groundmass is a plagioclase identified as oligoclase. It forms rounded grains 2 or 3 mm in diameter. The biotite occurs in even smaller particles, but so abundantly as to lend a dark color to the body of the rock which, apart from the feldspathic constituents, has the character of a biotite schist.

The rock in fact is really a modified schist, the original of which, consisting of biotite and quartz with subordinate feldspar, has been drenched with solutions or vapors from a neighboring granite mass. The presence of the latter at least as an underlying body, is indicated by numerous pegmatite dikes, some of large size, that are exposed in the vicinity and that contain the same feldspar ingredients as the schist itself. In the vicinity of the dikes the granitic material increases in proportion to that of the original schist and the rock becomes lighter colored and coarser in grain. The groundmass is more or less recrystallized and largely absorbed. The impregnation of hornblende and biotite schists by granites is a common feature of Adirondack geology, but usually it leads to the formation of striped or leaf gneisses in which the original schist and the granite alternate in parallel bands. In the present instance, however, the added igneous material lacks any definite arrange-

ment that might come from injection along definite planes, but is quite uniformly intermixed as if the impregnation had taken place with equal facility in all directions.

In consequence of the method of origin the rock varies in appearance and character from place to place, and there would be some difficulty in quarrying an even grade of product such as is required in building stone. It is a good material, however, for purposes of ordinary construction, in engineering works, foundations etc. Though it has not been tested for crushing strength, there is little doubt that it is fairly up to the average granite in that respect as well as in other physical qualities that make for durability.

Microscopically the rock appears quite fresh, except for incipient alteration of the feldspar which is somewhat sericitized. There are no sulphides; very little of iron oxides, with magnetite as the single representative; and no chloritic ingredients. Along with the secondary quartz and feldspar appears a notable amount of apatite in small prisms which is probably a pneumatolytic product incident to the granite invasion. The biotite is largely concentrated about the borders of the feldspar and quartz, as if it had been crowded out from the spaces occupied by the latter during their crystallization.

GRANITE NEAR GLOVERSVILLE, FULTON COUNTY

Gneissic rocks suitable for most purposes for which massive granite is used occur in the Adirondack Precambric area north and west of Gloversville. The boundary between the gneisses which form the Adirondack ridges and the Paleozoic sedimentaries at their base crosses Fulton county diagonally from northeast to southwest and is paralleled from Northville to Gloversville and Johnstown by the railroad which, however, is generally from 2 to 3 miles distant from the foot of the ridge.

The principal opening in the vicinity is the Edel quarry which is situated 3½ miles northwest of Gloversville and is worked by E. T. Edel of that place. It has supplied a large amount of architectural and constructional stone for the prosperous communities along the Mohawk river, having been operated more or less actively during the last twenty years. At present, building and curb stone are the principal products.

The rock is dark gray and though distinctly laminated shows little difference in appearance when cut parallel to or across the bedding. The grain is fine and compact, with some coarser particles of quartz and feldspar up to 3 or 4 mm in diameter scattered through the mass. The feldspar is mainly microcline. White

quartz, biotite and a little hornblende are the other ingredients. There are no sulphides, so far as observed. The material is well adapted for all general construction purposes, as it is strong and no doubt as durable as any massive granite of similar composition.

GRANITE AT WHITE LAKE, ONEIDA COUNTY

A pink granite has been quarried to some extent near White Lake station on the Mohawk and Malone branch of the New York Central Railroad. It is a medium-grained, compact, slightly gneissoid rock with very little dark components which consist of scattered grains of garnet and minute flakes of biotite. It represents a rather massive phase of the granite gneisses that are of widespread occurrence in the western Adirondacks.

GRANITIC ROCKS IN THE HIGHLANDS SECTION

THE STORM KING GNEISSOID GRANITE

The prominence at the northern portal of the Hudson gorge, known as Breakneck ridge, is made up of a homogeneous gneissoid rock that is generally called the Storm King granite. There is little doubt of its granitic derivation, and the foliated appearance which it generally exhibits is a secondary character superinduced since its first consolidation. The granite is exposed over many square miles, forming one of the larger areas of that rock in the Highlands. From the characteristic members of the gneiss series in the vicinity it is distinguished by its greater uniformity of composition and appearance and its usually more massive structures, while it is also lacking in any marked banding or similarity to a bedded arrangement.

The granite area is limited on the north by a great unconformity that separates the Highlands Precambric crystalline formations from the less metamorphosed Cambro-Siluric strata of the Middle Hudson region. This break marks also an extensive fault. On the other sides the area is not sharply defined by topographic or structural features, and the granite gives way to gneisses which are for the most part laminated and more or less conspicuously banded and which include siliceous and calcareous members. The gneisses are of early Precambric age, the banded sedimentary types being classed by Berkey as Grenville. The relations of the granite to these gneisses have not been definitely determined, but it appears likely from what has been learned that its intrusion took place early in Precambric time among the first igneous invasions that are clearly demonstrated in the region.

In general the rock is a medium-grained, grayish or reddish, somewhat gneissoid granite. Parts of the exposure are thoroughly massive. There is a more or less marked tendency toward pegmatization; streaks, dikes and irregular bodies of reddish pegmatite are in evidence in most outcrops, and the granite itself shows coarser phases produced by disseminated crystals of the same red feldspar that occurs in the pegmatite. Inclusions of a dark hornblendic rock also occur. They may represent dikes which have been broken and crumpled, or perhaps are bands of the surrounding gneisses which have been caught up in the granite at the time of its intrusion.

Jointing is usually a marked feature, but is irregular in direction except in the case of shear zones which are not infrequent. In these zones the rock is usually too broken to afford much dimension material. The surfaces of the sheared granite show some decomposition and are often coated with chloritic minerals.

The granite from this area could hardly be quarried economically for architectural building stone, but is serviceable for foundation or rough work, as well as for crushed stone. For crushing purposes it is fully equal to the average granite, as the foliation is not sufficiently developed to affect its strength or to cause the stone to fracture readily in that direction.

Quarries on Breakneck ridge

Quarry sites are found along the south side of Breakneck ridge for a mile or more back from the river and in the past have yielded large quantities of constructional stone, paving blocks and crushed stone. Quarry work began here in the early part of the last century, probably before 1825. For the last few years the output has been intermittent and small.

The principal operations have been carried on at Bailey's quarry just east of the river and 100 feet above the base of the ridge. The quarry face extends 300 feet east and west and is quite 100 feet in height. The quarries were equipped at one time with a crushing plant which supplied material for highways and railroads but this has been dismantled. The quarry work itself has not demanded much equipment as the plan usually followed is to break down the stone in large blasts and to utilize the product for different purposes according to its quality and size.

Microscopic examination. The granite belongs to the hornblende variety, having a dark green hornblende as the ferromagnesian

mineral. The other important ingredients are feldspar and quartz. The feldspar consists principally of microperthite and an acid plagioclase, and is sometimes intergrown with the quartz. There is a little magnetite but apparently no pyrite. The texture is even granular, compact, scarcely differing from that of a normal granite.

Quarries on Storm King mountain

There are quarries on the southeastern face of Storm King mountain, almost directly opposite those on Breakneck ridge. They were once worked for building stone and paving blocks, and Smock states that buildings in New York and Washington were erected from this granite. A few years ago the Storm King Stone Co. erected a large crushing plant here. No dimension stone has been shipped for a long time. The granite is very similar in composition and appearance to that on the east side of the river but carries some biotite as well as hornblende.

Old quarries, long since abandoned, exist on the south side of Crow's Nest mountain, and on the next ridge to the south which is partly occupied by the grounds of the West Point Military Academy. Some of the academy buildings are constructed of material from these quarries.

THE GARRISON GRANITE BOSS

King's quarry

A small area of massive granite is exposed north of Peekskill between Manitou and Garrison in Putnam county. It lies within the main gneiss belt that forms the more rugged part of the Highlands as exemplified in the Hudson gorge section from Anthony's Nose to Breakneck ridge on the east bank. The area is about one-fourth of a mile back from the river and 2½ miles from Garrison, a station on the New York Central and also a point for river shipment.

The outcrop appears to have the structure of a boss which has cut through the country gneisses but has not shared in their extreme metamorphism. The gneisses are Precambric and probably belong to the earlier or basal division of the series represented in this region. From the field associations the age of the granite intrusion can only be indefinitely fixed, with a probability in favor of late Precambric or early Paleozoic times. The proximity of the Cortlandt series, which is only a few miles to the south, as well as the

existence of a granitic facies among its highly differentiated representatives, might be regarded perhaps as suggestive of some relation with that invasion which took place as late at least as Siluric time.

A comparison of the Garrison and Peekskill granites shows that they resemble each other only in regard to color and their uniformly massive habit. The former is a representative of the normal alkali class of granites characterized by a preponderance of the potash feldspar over the lime-soda varieties; the Peekskill rock on the other hand shows by its high content of plagioclase an affinity with the diorite-gabbro series and, strictly considered, is to be classed as a quartz monzonite. The Garrison boss, also, is distinguished by a fine cataclastic texture, while the samples of the Peekskill granite seldom show any appreciable effects of pressure metamorphism. These features point more or less clearly to a separate, independent source of the two intrusives and the prior age of the Garrison boss.

The granite has been quarried quite extensively for building stone and foundation material, for which purposes it is very well adapted. The main opening is known as King's quarry, operated at one time by the King Granite Co., and later by Doern & Sons of New Rochelle.

Some of the buildings erected from material secured at this quarry are: St Joseph's Church, Tremont av. & Washington st., New York; Guard House at West Point; powder magazine on Iona island in the Hudson river; and a school building in Tarrytown. The property has not been worked extensively for the last few years and probably will not again be a very active producer. The granite boss, however, extends out on the adjoining lands, so that other quarries may be operated in the future. A site already prospected is found just south of King's quarry on the land of Raymond Moore of Peekskill.

Field characters. The general structure and quality of the granite are best shown at King's quarry which covers perhaps half an acre of surface and has a face up to 50 feet high. The principal structural feature is lent by the jointing which is well developed, especially the sheet joints. The latter divide the exposed rock into elongated horizontal lenses that are from 1 to 3 feet thick in the middle but increasing in size as depth is attained. The sheets are inclined slightly toward the northwest. Three sets of steeply inclined joints also occur, of which the most prominent strikes north and south and dips 70° east; another set strikes N. 40° W. and dips 70° southwest; and the third strikes east-west and dips 60° north. The rift is stated to be about parallel with the first set.

In physical appearance the granite is characterized by a fine grain, medium gray color of body that is well blended, and massive to faintly gneissoid texture. Small crystals of garnet are sparsely scattered through the mass but are noticeable only on close view. There are few streaks or discolorations apparent in the exposure.

Microscopic examination. The rock consists essentially of feldspar, quartz and biotite in order of importance, with garnet as an accessory which has probably been formed by a partial recrystallization of the minerals caused by compression exerted upon the boss after its intrusion. The feldspar and quartz are in irregular particles closely interwoven. Their average diameter is about 5 mm. The biotite is in very fine beds, sprinkled like dust through the gray groundmass. The texture is close and firm.

The feldspar minerals include microcline, microperthite and orthoclase as representatives of the alkali class and an acid plagioclase which has subordinate importance to the others. They are but little altered. The biotite is somewhat bleached or partly changed to chlorite. The absence of pyrite or other igneous ingredients is noted.

Physical tests. The granite from this quarry has a specific gravity of 2.68, ratio of absorption .3 per cent, and pore space .792 per cent.

ROUND ISLAND GRANITE

Round island, in the Hudson just above Peekskill, is made up of granite which at one time was actively quarried for crushed stone. The quarry was worked up to ten years ago by Daniel Donovan of Kingston. The site of the quarry was not visited by the writer and there are no details available as to the character of the stone aside from the following chemical analysis, supplied by Mr Donovan:

SiO_2	63.19
Al_2O_3	10.50
Fe_2O_3	10.97
FeO	1.51
CaO	6.12
MgO	1.44
K_2O	4.02
Na_2O	1.92
Loss	.18
Undet.	.15
	100.00

THE PEEKSKILL OR MOHEGAN GRANITE

Granite intrusions are found on the borders of the area occupied by the Cortlandt series, which is the name given to an interesting group of basic igneous rocks exposed to the south and east of Peekskill. The Cortlandt series comprises diorites, gabbros, norites, pyroxenites and other types of basic habit, with such relationship as to indicate that they represent the differentiated products of a single deep-seated magma. Their intrusion took place probably as late as Siluric times since the series breaks through and includes portions of the metamorphosed sediments that are classed with the Hudson River series of the Lower Siluric. Their outcrop extends over an area 5 miles in east-west diameter and about 4 miles from north to south, in outline an immense boss.

The granite exposures are on the north side of the Cortlandt area and immediately adjacent to it. The first outcrop encountered on the west is a mile or so out of Peekskill on the little knob lying between the Lake Mohegan road and the east-west highway, just west of the line of the Catskill Aqueduct. The locality is known as the Roberts quarry. Millstone hill, which lies a mile farther east and south of the east-west highway, is made up in its northern slopes of granite, but is apparently near the contact with the basic rocks of the Cortlandt series which appears on the next prominence to the west. A third place where granite appears in force is across the valley from Millstone hill, on the south and west slopes of a ridge, about a mile south from Lake Mohegan. The Mohegan Granite Company has quarries at this locality.

In the several exposures which embrace between them an area of 3 or 4 miles, there is naturally some variation in the appearance and composition of the granite, though as a whole the samples from the different quarries exhibit a degree of uniformity which would seem to establish their identity with one and the same intrusive mass. This uniformity is reflected in the predominance of white feldspar, mainly orthoclase, albite and oligoclase, which gives a light tone to the rock wherever exposed, in the presence of both biotite and muscovite, a moderate to small content of transparent quartz, and in the granitic texture which ranges from medium to fine grained. It appears probable that the different quarries are located on outcrops of a single body which has the Cortland series on the southwest and lies against the metamorphic rocks, including Paleozoic schists, on the remaining border. The exact extent and shape of the mass is somewhat indefinite, as there is a heavy cover-

Plate 18

Part of the Mohegan Granite Company's Quarry, Peekskill

ing of soil and detritus over the low ground that intervenes between the exposures.

Owing to the prevalence of plagioclase among the feldspars represented, the Peekskill granite shows a relatively high proportion of soda as compared with most granites and appears to be genetically allied with the diorites of the Cortlandt series. This feature, as well as the field relationships already mentioned, lends support to the view expressed by Berkey[1] that the granite represents but a phase of the Cortlandt invasion and not a separate body; it constitutes the acid extreme of the series which in the other direction range through diorite, gabbro and norite to rocks like pyroxenite and peridotite that are destitute of quartz and feldspar.

The granite like the typical Cortlandt rocks, is thoroughly massive in texture, lacking evidences of strong compression and the gneissoid development which are so common among the Precambric and early Paleozoic rocks of this section. Its intrusion occurred therefore after the period of regional metamorphism that marked the close of Lower Siluric time — the last stage in the general metamorphism of the region. The contact of the granite with the country rocks is very generally concealed, but inclusions that apparently represent the bordering schists are not infrequent and sufficiently establish the nature of the contact relations in that respect. The latest of the country schists belong to the Hudson River series. The inclusions mostly in evidence are amphibolites and dark hornblende schists which undoubtedly came from some of the earlier and underlying formations.

The view expressed as to the common derivation of the granite and the Cortlandt rocks can not be supported by observations in regard to their mutual contact relations, as such information was not procurable when the writer visited the locality. There seems to be complete similarity, however, in their attitude with respect to the crystalline schists, and the field evidences, so far as they go, are indicative of a geologically contemporaneous intrusion for both granite and gabbros.

Mohegan Granite Company's quarries

The quarry property of the Mohegan Granite Company is situated a little east of the Cortlandt township line in Yorktown, Westchester county, on the southwestern slope of a prominent ridge

[1] Science, 28: 575, 1908.

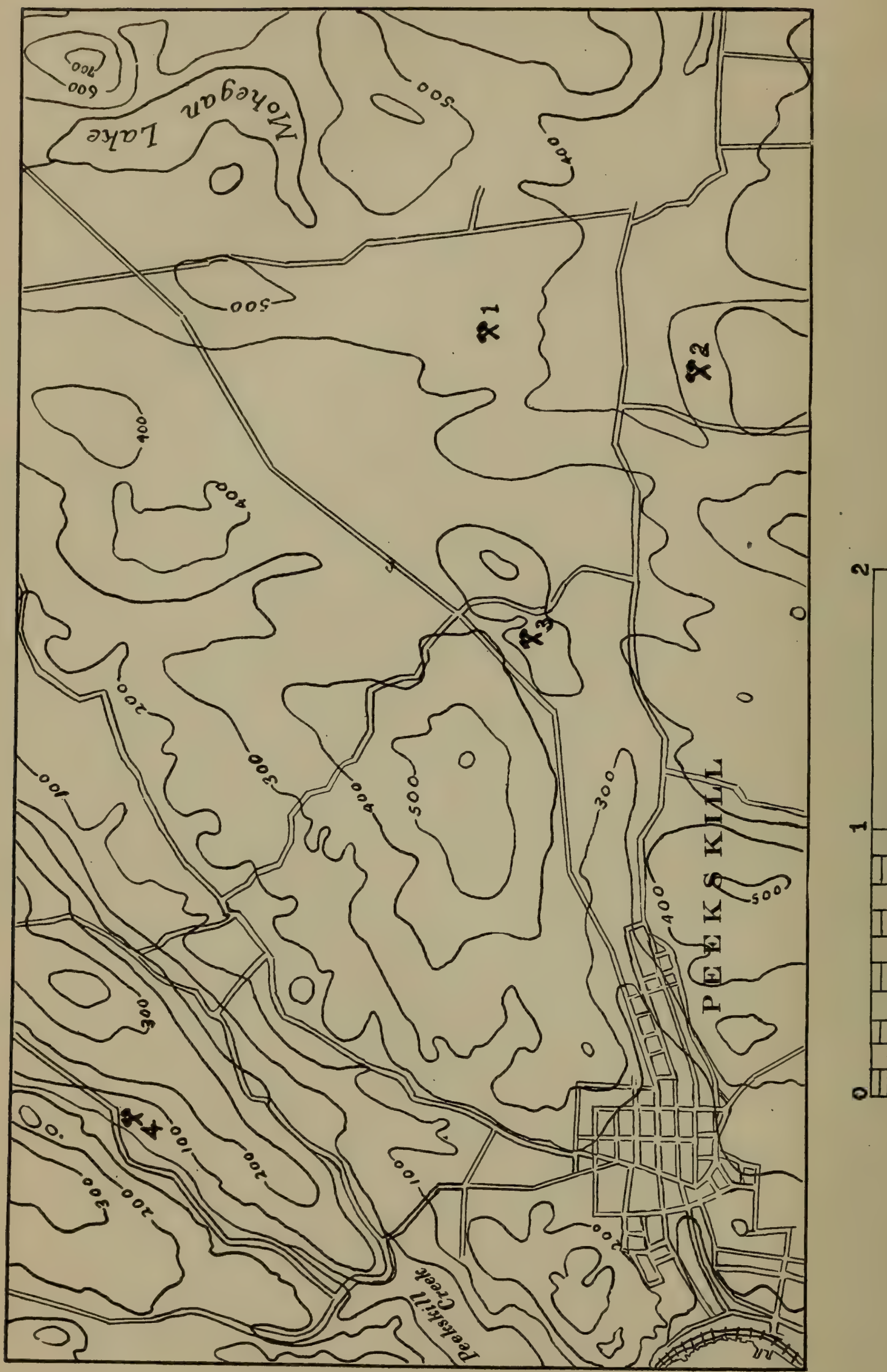


Fig. 10 Map of the quarries near Peekskill. 1 is Mohegan; 2, Millstone; 3, Roberts quarries, all in granite; 4, Frost quarry in crystalline limestone

which extends northward past Mohegan lake. The workings lie between 400 and 500 feet above tidewater at Peekskill and 5 miles distant by the highway. Regular quarry operations date from 1892 when the granite was wrought by E. P. Roberts for the construction of the dams at Carmel and Purdy station in connection with the New York water supply. The granite was later selected, after an extended search for material adapted to the purpose, for the construction of the Cathedral of St John the Divine, the largest church edifice in America, and during several years the quarries have been engaged in supplying cut stone for that structure which will require shipments for some time to come. It has been used also in other buildings in New York, including the residences of Charles M. Schwab on Riverside drive and of Clarence W. Bowen on 63d street, the Postal Telegraph Building on lower Broadway, the Cross Building on Fifth avenue, and several of the houses in the Bronx Geological Gardens. It has also found considerable sale for monumental work, examples of which may be seen in many of the larger cities of the east.

The quarries furnish two varieties of the granite, a light gray of more or less pinkish hue and a rich yellowish brown that is almost a golden yellow when seen at close range. The yellow granite has no match in beauty and uniformity of its color among eastern granites and its warm, subdued effect in buildings has won favor wherever the stone has been introduced. The light gray color is characteristic for the Peekskill granite as a whole and occurs below the yellow at varying depths, but usually the change occurs at or about 40 or 50 feet. The color variation so pronounced at these quarries seems to be purely local, the yellow granite occurring nowhere else and being the result, as later explained, of secondary influences at work since the consolidation of the intrusion and its exposure at the surface.

The quarry openings extend over a distance of several hundred feet on the hill slope, which falls off rather steeply to the west. The thin soil covering supports a moderate forest growth and serves to conceal the outcrop over much of the undeveloped ground. The granite is known, however, to cover an extensive area. The principal quarry is at the south end, and runs northeasterly for 300 feet, showing a face against the hill of about 40 or 50 feet. This quarry is served by a short inclined tramway on which the cars are raised and lowered by a cable. The granite has a slightly sheeted structure, the sheets dipping 15° or 20° west. There are two principal joint systems, one vertical with a strike of N. 70° E.,

and the other inclined 80° or 90° and striking N. 30° W. The rift is about north-south and nearly vertical. The joints are irregularly spaced, usually at fairly wide intervals, but in one place form a heading where only material for crushing purposes is secured. Dimension stone of almost any merchantable size can be quarried.

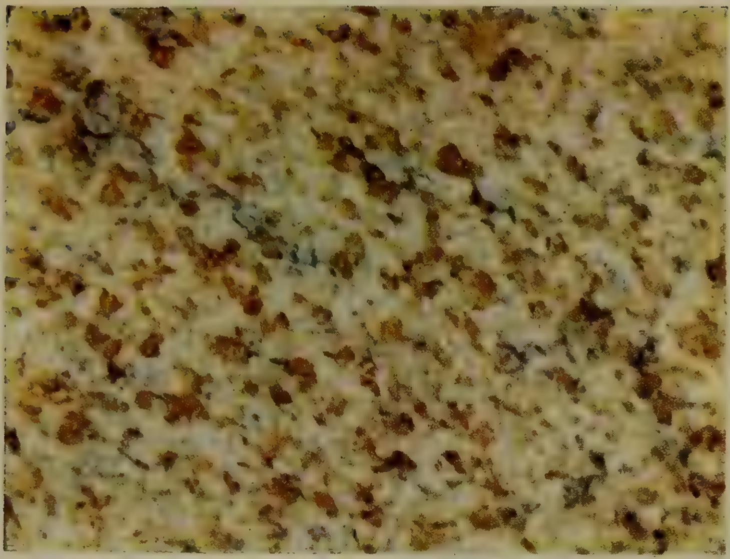
Knots and streaks are rare and dikes apparently absent. There are occasional inclusions of the country schists, the larger ones being on the northwest and east sides of the quarries. A conspicuous example which is found on the north side of the incline consists of black hornblende schist that has been injected by granite and pegmatite and forms a vertical wall for a short distance, wedging out finally in the granite which apparently surrounds it completely.

The quarries are equipped with modern machinery for breaking, hoisting and cutting the granite, but as yet are scarcely developed to the stage that admits the most advantageous operations. The stone is mostly dressed on the ground. The cost of haulage by wagon to Peekskill makes that necessary. Increased facilities for cutting have recently been provided by the erection of a steel-frame shed of dimensions 130 by 50 feet. The capacity for turning out finished material is thereby more than doubled. The equipment at the quarries includes a 50-ton crushing plant for working up the waste material.

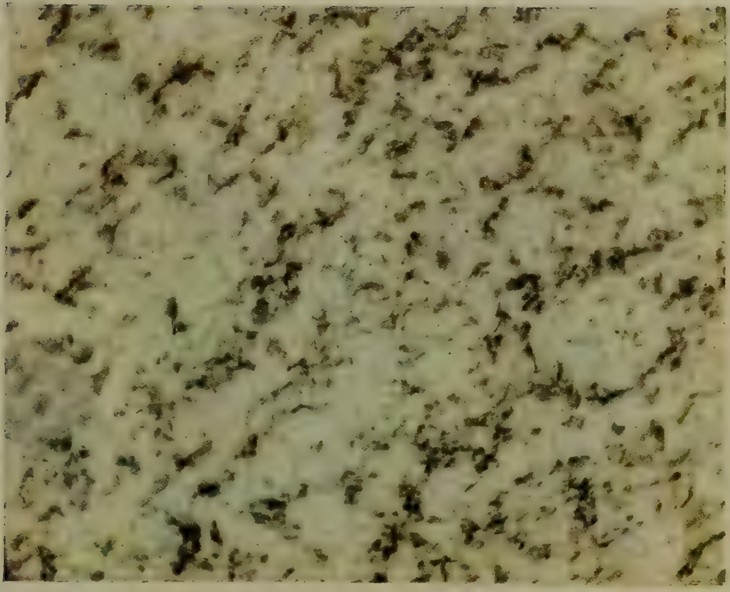
Microscopic character. The granite from this locality belongs to the medium-grained class, inclining toward the finer end of the scale. It is a mixture of feldspar, quartz and mica in their order of abundance. The feldspar and quartz are mostly under .25 cm in diameter, the quartz individuals occasionally slightly exceeding that limit. The mica includes both biotite and muscovite and is so finely divided and evenly distributed as to be little noticeable except against the white background of the light gray granite. The feldspars include albite, oligoclase and subordinate orthoclase, all of which show incipient alteration by their clouded appearance under the microscope. Chlorite is sparingly present as an alteration product of the biotite. The accessory constituents include magnetite, zircon and apatite in very small amounts.

The yellow or golden hue characteristic of the superficial part of the granite is due to the presence of a little limonite stain distributed along the borders and microscopic cracks of the quartz and feldspar, particularly of the quartz which seems to carry most of the coloring matter. The stain is not accompanied by any marked softening or decomposition, contrary to what might perhaps be expected, for

Plate 19



Mohegan yellow granite. Peekskill



Mohegan gray granite. Peekskill

the granite when examined microscopically appears little more weathered than the gray variety. The apparently even distribution of the coloring matter when the rock is viewed in the mass disappears on closer examination and the stain is seen to be developed in flecks and lines scattered over a white background of feldspar and quartz. Most of the limonite is found in the quartz which is the ingredient that shows the most granulation and consequently the

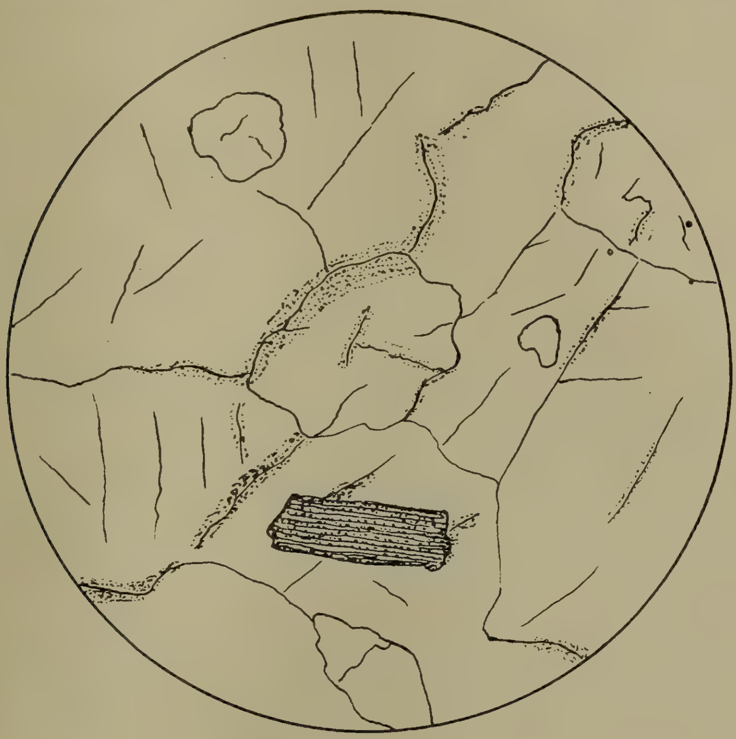


Fig. 11 The yellow Mohegan granite, showing concentration of limonite along the borders and in the cleavage cracks of the mineral particles

most open space for its deposition. The source of the limonite is traceable to iron-bearing solutions from the surface which found their way downward along the joints and then diffused through the rock by means of the capillary openings. It may have been derived from decay of the overlying rock in the long period of exposure previous to Preglacial time, but of such a zone of disintegration there is no remaining evidence at present and is hardly to be expected after the erosive work of the ice. The limonite often seems to be concentrated about the biotite, but this is not a result primarily of a chemical alteration of that mineral, but rather arises from the infiltration of the iron along the cleavage planes of the biotite. Much of the biotite is perfectly fresh, showing no bleaching or other change that could result in freeing any of the iron. In some of the

sections examined a small proportion of the flakes showed partial or complete change to chlorite. The amount of iron set free from the biotite in any case is entirely insufficient to produce the present color.

Chemical and physical features. The following data in regard to the granite was supplied by the Mohegan Granite Co. in 1904 in response to the request from this office. The tests were made on four separate samples in the laboratories of Ricketts & Banks. It was not specified whether they were based on the yellow or the gray variety.

Sample	Iron per cent	Sulphur per cent	Specific gravity	Crushing strength lbs. a sq. in.
1	.34	.015	2.64	21,979
2	.86	trace	2.62	19,303
3	.30	.022	2.64	12,547
4	1.15	.015	2.67	16,889

The lower crushing strength of no. 3 is accounted for by a defect in cutting the sample which resulted in the loss of a chip from one corner. The tests evidence the physical soundness of the granite and confirm the results of quarry and microscopic examinations. The weathering qualities of the granite are considered excellent. The pyrite content as indicated by the sulphur percentage is too small to have any influence.

A sample of the light gray granite tested by the writer had a ratio of absorption of .319 per cent and pore space .829 per cent. The yellow granite showed a ratio of absorption .368 per cent, pore space .962 per cent.

An analysis of the granite from this quarry by Elwyn Waller is given herewith:

SiO_2	73.32
Al_2O_3	15.01
Fe_2O_3	.47
FeO	1.19
MgO	.15
CaO	1.35
Na_2O	4.27
K_2O	3.72
H_2O+	.13
TiO_2	.06
MnO	trace
Total	99.67

Millstone Hill or Cornell quarry

The largest opening in the Peekskill granite is on Millstone hill south of the highway leading east from Peekskill and adjacent to the line of the Catskill Aqueduct. It is across the valley and a mile distant from the Mohegan Granite Company's quarries, in Cortlandt township. The main development of the property resulted from the operations by Coleman, Breuchaud & Coleman, the contractors for the new Croton dam which was constructed entirely from material secured at this place. The quarry has furnished also some stone for buildings in the vicinity, notably the Drum hill school at Peekskill. It has been idle for the last few years, but recently has come into the control of Rudiger Brothers who aim to reopen it.

The quarry lies east and west on the ridge, about 150 feet above the highway. The lower ground is heavily covered with soil and drift. The excavation measures about 500 feet long and 200 feet wide in extreme dimensions and has been carried downward to a depth ranging from 30 feet on the north side to 75 feet on the south. No hoists or other equipment are standing on the property. In the period of operation the stone was transported on a tramway to the Croton dam, but the road has been torn up. The outlet is by way of Peekskill to the railroad or the Hudson river, involving a haulage of about 4 miles.

In the quarry the granite shows the characteristic massive structure; joints are rather wide apart and irregularly spaced, except on the west end where they form a heading. The joint systems include a north-south series which dips 80° west and an east-west vertical series. Horizontal division planes have little persistence, hardly justifying their reference to sheeting, though there is some tendency toward division on planes dipping slightly south and west. The rift is reported to run parallel with the north-south joints. No dikes or large inclusions are observable in the quarry walls.

At this quarry there is no capping of yellow granite, so prominent in the Mohegan property, and the only suggestion of any color change consists of a slightly mottled effect produced by a little limonite stain around the biotite crystals, like the rust on iron. This is apparently the initial step in the transformation from gray to yellow. The granite from the deeper parts of the quarry, however, is entirely free of limonite with a very uniform body that appears almost white. The quality is excellent for all architectural purposes.

Microscopic character. Feldspar is first in importance as a constituent and consists mainly of albite or acid oligoclase with subordinate orthoclase. The individual crystals often show marked zonal structure. Alteration is evidenced by clouding and the development of muscovite and probably also of kaolin. The quartz is slightly gray or smoky in color. Of the micas, muscovite is equally common with the biotite variety and occurs in original crystals, as well as secondary growths from feldspar. The biotite shows partial change to chlorite. Iron ores are very scarce except for the little limonite that occurs in the exposed part of the granite. The grain may be classed as medium, the coarser particles of feldspar and quartz attaining a diameter of 10 mm. The interspaces are filled up with finer interlocking individuals and the texture is very compact.

Crushing strength. A crushing test performed by Ricketts & Banks on a sample from the quarry, as communicated by J. M. Rudiger, showed an ultimate strength of nearly 21,000 pounds to the square inch. The details are as follows: size of cube, 1.99 by 2 by 1.99 inches; area 3.98 inches; breaking strain 83,100 pounds; ultimate strength 20,870 pounds a square inch. The granite is unquestionably strong and durable.

Roberts quarry

An exposure of granite occurs in the knob lying just southeast of Jacobs hill and between the Peekskill-Lake Mohegan road and the Catskill Aqueduct. It is more than a mile west of Millstone hill. The knob is of small compass, a few hundred feet in diameter and less than 100 feet high. It has been opened on the southeastern side to supply stone for local construction. The quarry is only about a mile out of Peekskill and appears to be located at the most accessible point of the granite area.

The quarry cut is about 100 feet long, with two small-sized derricks in place. The granite is well jointed along two directions, N. 60° W., and N. 20° E. but is not sheeted.

The stone differs considerably in texture and appearance from that exposed in other parts of the area, but the general composition, so far as the nature of the mineral ingredients are concerned, is similar. It has a coarse grain which is made very prominent by the large micaceous aggregates of dark color, whereas the body of feldspar and quartz has the usual light hue. These aggregates formed by intergrowing muscovite and biotite attain a diameter of half an inch; they are oriented parallel with the rift, and to surfaces

cut in that direction lend a mottled aspect. The quartz and feldspar are in granulated condition, probably the result of compression upon what originally were large crystals but are now finely comminuted. There is some limonite stain in zones about the mica.

The granite at this quarry appears darker when observed in mass than the average of the other quarries. It would be classed as medium gray, with a pinkish tone, the pink being fairly decided in places.

As a variant of the Peekskill granite boss may be mentioned an outcrop which lies but a few rods to the east of the Roberts quarry and undoubtedly is a part of the intrusion. It is characterized by the abundance of mica, much greater in amount than observed in the rock elsewhere. The color as a consequence is quite dark. From microscopic examination the feldspar appears to be almost entirely plagioclase and to predominate largely over the quartz. The rock by itself would be classed as a granodiorite, and the occurrence serves to bring out the close relation that probably exists between the granite and the more basic types which constitute the Cortlandt series proper. The ledge is too small to have any importance for quarry purposes.

THE YONKERS GNEISSOID GRANITE

A light-colored granite with a markedly foliate texture is found in southern Westchester county where it is the basis of rather extensive quarry operations. Under the name of the Yonkers gneiss it has been described by Merrill and others and its igneous derivation clearly established. The fact, however, that the foliated appearance in the main is not the result of secondary recrystallization or metamorphism, but an original feature imparted during the first consolidation of the magma has not been generally recognized. On account of this fact it seems more appropriate to call the rock granite than gneiss, the latter term implying, as it does, the effects of metamorphism.

According to the recent work of Berkey, the Yonkers is probably to be classed with the early Precambric series of intrusions which are represented in the Highland region by the Storm King boss. It seems to be confined to thin sills which are intrusive in the Fordham gneiss. The development of the parallel arrangement of the constituents may be explained as the effects of compression exerted during the intrusion of the granite while it was still in a condition of mobility, facilitated by the relatively thin mass of the granite. There is little in the way of secondary crystallization as

seen in acid gneisses. Examples of what appears to be crushed and sheared gneiss are frequently observable in the field but they are probably the result of viscous flowage of the magma.

The granite outcrops in several areas. The principal belt within which most of the quarries are situated parallels the Bronx river and Harlem Railroad from a point a little south of Mount Vernon to Hartsdale, near White Plains. The outcrop lies along a series of hills and ridges between the Bronx and the parallel valleys of Tibbitt and Troublesome brooks. Its surface shows only moderate relief, the highest elevations slightly exceeding 300 feet, with intersecting notches and cross-valleys whose bottoms mostly are between 100 and 200 feet. The main intrusion is nearly 10 miles long, but not much over one-half of a mile wide. This form doubtless results from a sill or sheetlike intrusion of the original granite which penetrated the sedimentary formations of the Fordham along the bedding planes and has since been upturned so as to afford a longitudinal section.

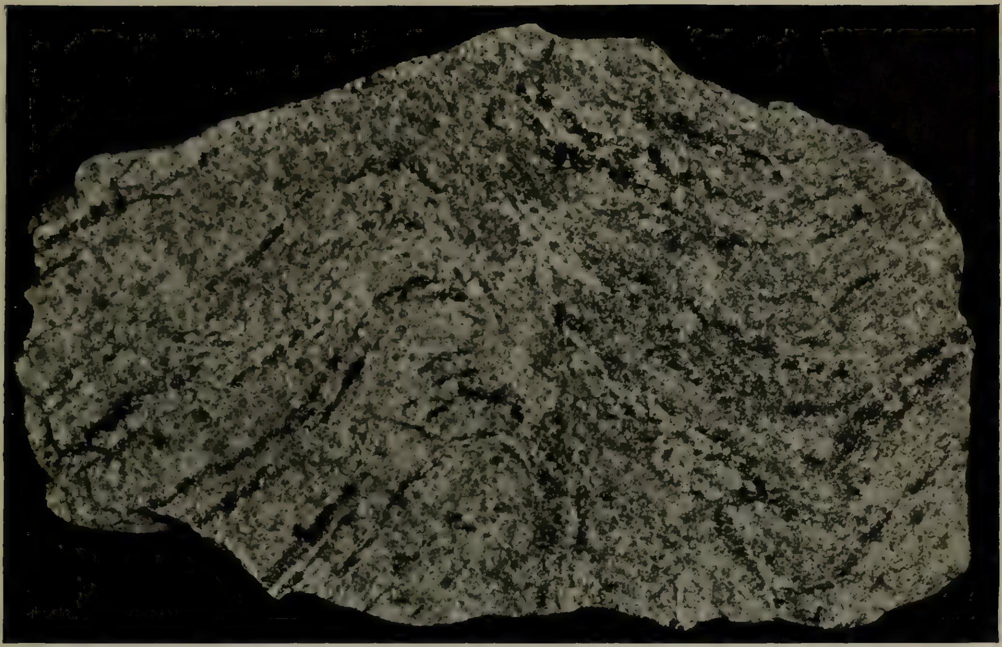
A second area of the Yonkers occurs along the axis of the main belt farther north, near Valhalla and the Kensico reservoir. This has not been so actively worked as a source of building stone. There are a few quarries, however, that have been operated at different times, mainly to supply foundation material, including that used in the Kensico dam.

General characters. The Yonkers granite varies more or less in physical structure and appearance. This observation applies even to the limited area of a single exposure, where occasionally the characteristic thinly foliate rock may be seen grading over into a quite massive one. There is little variation, however, in respect to the mineral composition, and the whole rock mass is quite free from segregations and inclusions. The quarry sites in most instances have been selected with a view to uniformity of the material which is obtainable to a fair degree. Eckel[1] describes the general features of the Yonkers as follows:

The color of the Yonkers gneiss varies from a light blue to a rather deep red. This variation is partly due to the fact that the blue grades in most cases contain more quartz and less feldspar. A much more potent cause, however, is that the feldspars themselves are either red or bluish. This difference in color is not due to a difference in the feldspar species, as the microcline and sheared orthoclase appear in both the red and blue Yonkers, and in about the same relative proportions.

[1] The Quarry Industry of Southeastern New York. N. Y. State Mus. Rep't 54, 1902, p. 155.

Plate 20



Yonkers gneissic granite, showing plastic yielding and flowage. Kerbaugh quarries, Kensico.

Graphic granite, an intergrowth of quartz and feldspar. From Bedford, Westchester county.

The difference of color is of importance economically. The red forms decay rapidly, while the blue, though often becoming stained yellow by iron, do not appear to disintegrate. The writer has not been able to follow up this investigation as far as he could have wished, and the discussion in this paper should be regarded as merely preliminary to a more detailed presentation of the subject.

The inference in the above quotation that the color variation has significance with respect to the durability or weathering qualities of the granite claims attention, though no explanation is vouchsafed in the paper. The present study has not afforded any clear evidence of such relationship. There is apparently a wide difference in the capacity of the granite to withstand disintegration, but this feature seems more related to the textural characters than to any peculiarities of the mineral constituents that are reflected in the color.

Some natural surfaces are practically fresh, though they have been exposed to atmospheric conditions since Glacial time. In other places the granite is disintegrated to some depth. The first stages of weathering are usually manifested in a weakened cohesion of the mineral particles, as the result of the alternate expansion and contraction under varying temperatures. The microscopic cracks and pore spaces are enlarged with the progress of weathering. The final stage of this physical disintegration is reached when the rock becomes a loose, mealy aggregate of quartz, feldspar and mica. Chemical decay, of course, accompanies the physical breakdown and is first evidenced in the separation of iron oxide and the softening of the feldspar, but it is mainly effective after the rock has undergone partial disintegration.

It is evident from a study of the granite in the field that the texture has much to do with its weathering qualities. The types which are characterized by a closely knit fabric, with the individual grains well interlocked, as observed in most unchanged granites, are resistant to weathering. Such textures are found in the massive varieties of the rock and in the foliated types which have not undergone noticeable granulation from shearing action. The granular even-textured types, on the other hand, are apt to be of more porous nature and more prone to disintegrate.

The Yonkers is quite free of knots and streaks arising from irregular mineral distribution. The principal variation relates to texture and grain. Coarse, massive phases occur here and there as a kind of pegmatitic development. Some exposures are only moderately foliated. The characteristic rock, however, is thinly foliate, with the biotite interleaving the quartz and feldspar at regular intervals.

The granite, with the exception of the very granular sorts as noted above, is a serviceable stone for all general construction purposes. It has no ingredients to cause discoloration or decay with the lapse of time. Its durability, when subjected to mere weathering, can scarcely be inferior to ordinary granite, though of course it has not the same ability to withstand abrasion or wear, on account of its tendency to cleave along the foliation planes. The many buildings in Yonkers and vicinity that have been constructed of this stone are evidence of its good quality as a structural material.

Microscopic examination. The mineralogy of the granite is simple; feldspar, quartz and biotite are the components in order of their relative importance. The feldspar is divided between orthoclase and microcline, with a little plagioclase. The quartz has a bluish tint and with the biotite often lends a decided bluish cast to the cleavage surfaces, whereas the color across the foliation is prevailingly pink, like that of the feldspar. Under compression, the quartz has developed into lenticular or spindle-shaped individuals, while the feldspar has been corroded and broken down into small irregular particles.

The subordinate constituents include hornblende, iron oxide, titanite, and zircon. Sulphides appear to be absent from the mass of the rock. There is little change noticeable in the thin sections, except a slight kaolinization of the feldspars and separation of small amounts of iron from the biotite.

The rock is fine to medium in grain. The lines of foliation marked by the biotite are mostly spaced from 4 to 10 mm apart.

Quarry development. Quarry work in the Yonkers belt has been carried on for a long time, but until about twenty years ago did not reach any considerable proportions. Eckel states that most of the quarries operative at the time of his report were opened around 1892. At that time, and in the few subsequent years, there was unusual activity in building and engineering construction, particularly by the railroads, which had a great deal of work in connection with bridges and retaining walls under way. The market for stone, however, was mainly local, and with the completion of these improvements the demand so declined as to compel the closing of many quarries. The present outlet is principally for building stone, as illustrated by many public and private structures in Yonkers and vicinity, also in partly dressed condition for foundation work, and as blocks and crushed stone for road improvements.

A number of quarry sites mentioned in the earlier descriptions of the industry by Smock and others have been converted into building plots or otherwise utilized so as to exclude their further exploitation for stone. Some of the more important of the old quarries, not now worked, will be mentioned here for the purpose of record.

The Valentine quarries are described by Mather as operative at the time of this report (1842) and are also referred to by Smock. They were situated 2 miles southeast of Yonkers, on the Mount Vernon road. They were worked at intervals when Smock made his report and have since been abandoned.

A quarry on the Stewart estate, near Dunwoodie, was worked for several years by O'Rourke Brothers of Yonkers. It supplied rough and cut building stone and crushed stone. Production ceased in 1908.

The McCabe quarry in the town of Scarsdale, about a mile east of Hartsdale, was opened in gneiss similar to the Yonkers, but lying off the main belt. The output was mainly crushed stone, with some rough foundation stone. The quarry has been idle for about ten years and will not again be worked.

An unnamed quarry, situated about an eighth of a mile north of the preceding, in the town of White Plains, near the Cambridge road, was operative a few years ago, but has now been permanently abandoned. It produced rough and cut building stone and road material. There was much waste, owing to pegmatitic admixture and the closely spaced joints. The opening was 400 feet long, exposing 40 feet of a light variety of gneiss, not distinguishable from the Yonkers in its characteristic occurrence.

A small quarry once existed in the town of North Castle, about a mile northeast of Silver Lake, and was known as the Collins quarry. The rock, according to Eckel, was reddish foliated gneiss of the Yonkers type. Production was restricted to local needs and it has been closed in recent years.

The quarry once worked by Dennis Cahill and situated on Reidland avenue, east of Central avenue, has been permanently closed.

The Flannery quarry in the same vicinity has produced a small quantity of stone in recent years, but will not be worked in the future.

The Seely quarry, one-half of a mile west of Scarsdale, has been abandoned many years and probably will not again be worked.

The Ferris, Dinnan and Outlet quarries are old openings in the body of Yonkers gneiss near Valhalla.

Hackett quarry

Hackett Brothers, of Yonkers, have operated a quarry for several years in the northern part of the main Yonkers belt. Their property lies about a mile north of Dunwoodie, at the junction of Midland and Central avenues, and is opened for a distance of 800 feet along the course of the gneiss.

The working face is about 40 feet high. The quarry has furnished a large amount of building stone, which is its chief product. Some of the larger structures in which the stone has been used are: St Joseph's Seminary, Dunwoodie; Seton Hospital, Spuyten Duyvil; St Joseph's Hospital, Yonkers; St John's Hospital, Yonkers; St Dennis Church, Lowerre; and public school buildings Nos. 3, 9, 10, 15, 18, Yonkers. Polished examples are shown in the columns of the county jail at White Plains.

The rock is characteristic Yonkers, rather fine in grain and of bluish color, as seen in the quarry ledge. This color becomes more of a pink on the cleavage surface of hand specimens, owing to the fact that the colored feldspars are much pressed out along the foliation. The hammer-dressed surfaces are a medium gray. The stone is free of spots and discolorations.

The gneissoid foliation at this locality is quite regular in direction and character. The strike is N. 30° E. and the dip vertical or slightly turned to the west. Horizontal joints are well developed, at an average of from 3 to 5 feet apart, permitting bench operations. A second system of joints parallels the foliation, and the third strikes N. 65° W. and dips 80° W. The structure is well suited to the production of dimension stone. The rift, of course, runs with the foliation.

In quarrying, the stone is broken out by black powder. Holes are put down about 10 feet by a steam drill. This method naturally yields a large quantity of material unsuited for building stone and this finds sale for rough foundation work, particularly in macadam and telford roads. There are two derricks in place. The average force is about ten men. Shipments by rail are made by the Putnam division of the New York Central Railroad.

Perri quarry

A quarry, operated by Louis Perri, is situated on the east side of Central avenue, across from the Hackett property. It is just west of the site of the old O'Rourke quarry, now converted into building lots. The opening at this place is about 100 feet long and affords a face about 30 feet high, practically unweathered to the surface.

The rock is uniform in color and grain, representing a good quality of the Yonkers gneiss. The foliate texture is prominent and has a north-south strike with a vertical dip. The joint structures include a horizontal set spaced about 8 feet, along which the stone is quarried in benches. There are also north-south and east-west sets spaced about 20 feet apart. On the north side of the quarry, the east-west joints are more crowded, practically forming a heading, and the rock in that section is adapted only for road material.

The quarry is worked in a small way and the stone mostly sold dressed as lintels, sills etc. Hand drills are used and the stone broken out by black powder. The only mechanical equipment is a horse derrick. Some good-sized blocks are quarried, the largest measuring about 3 by 6 by 8 feet. The rock breaks quite smoothly along the foliation.

Russo quarry

A small quarry has been opened in the last few years and recently operated by John Russo. It lies about 1000 feet south of the Hackett quarry on Midland avenue, near Dunwoodie. The rock is the same fine-grained bluish or pinkish gneiss, of foliate structure, but is rather more broken than at the former quarry. The vertical and horizontal joints are mostly spaced at intervals of 2 or 3 feet, so that large-sized blocks are seldom quarried. The product is building stone, employed locally in the construction of dwelling houses. The scrap and inferior quality rock are sold for road material. The work is all done by hand.

A microscopic examination of the gneiss from this quarry shows that there is considerable hornblende in addition to biotite, which is the prevailing dark mineral. The feldspars and quartz are partially granulated and the uncrushed remnant is drawn out along the planes of foliation, the larger and smaller particles often occurring in alternating bands. The rock is quite fresh, except for the incipient alteration of the biotite. This has set free some iron which as limonite forms a slight stain along the cracks and sutures. Zircon and titanite are fairly abundant accessory minerals. The average diameter of the quartz and feldspar particles is between .5 and 1 mm, so that the texture is unusually fine.

Beekman quarry

The Beekman quarry is perhaps the oldest of the quarries in the Yonkers gneiss. It was worked in the early part of the last century and has been operative at intervals down to the present. It is situated at Phillipse Manor, about a mile north of Tarrytown,

and is thus outside the principal areas of Yonkers. The principal opening reveals a bluish gneiss which is much fractured and intersected by a pegmatite dike. The latter occupies nearly one-third of the face which measures 60 feet in width. The gneiss strikes north and south and dips 60° east. When visited in 1911, the quarry was equipped with one steam drill and a rock breaker. In recent years the output has been used on the estate of which the quarry is a part for road and foundation work.

South of the main cut is an opening in a bluish and pink variety of gneiss. The blue is much jointed, while the pink gneiss appears to be very brittle.

The Beekman quarry has supplied material for several structures in Tarrytown, including churches and other buildings.

Kensico quarries

The principal quarry development of recent date in the Yonkers gneiss is that of H. S. Kerbaugh, Inc., the contractor on the new Kensico reservoir which is to form a part of the Catskill water supply system. To increase the capacity of the reservoir, a dam that will be 100 feet higher than the old structure and of correspondingly massive proportions is in course of erection at Valhalla at the south end of the reservoir. This structure is to consist of Yonkers gneiss obtained from an area explored to the east of the ridge, about one-half mile northeast of the dam.

The geological features of the reservoir site have been presented by Berkey,[1] who also investigated the various quarry materials of the vicinity with the view to their adaptability for use in the work. The Yonkers gneiss is an outlier of the main belt and is exposed on the ridge to the east of the reservoir, while the west side is made up of Manhattan schist, with Inwood limestone in concealed outcrop between the two.

Berkey mentions several quarries in the vicinity that have not been previously noted. These include the Outlet quarry, 1500 feet east of the northern extremity of the old reservoir; the Ferris quarry 1000 feet farther north; and the Dinnan quarry 3000 feet north of the Outlet quarry. All these are in Yonkers gneiss or massive phases of that rock. In addition he mentions the Garden quarry, about midway of the reservoir and 500 feet east of its margin, opened in dioritic gneiss; the Smith quarry, less than 1000

[1] Geology of the New York City (Catskill) Aqueduct. N. Y. State Museum Bul. 146, 1911, p. 191–200.

feet east of the southern end of the reservoir, in a mixture of igneous and Fordham gneisses; and the City quarry, on the eastern margin of the reservoir, also in a mixed phase.

The quarries from which the supply of stone for the dam is being obtained are apparently a new location, considerably south of the others in the Yonkers area. They are based on an exposure of several acres, thinly covered with soil which, when removed, shows glaciated but practically fresh rock at the surface. The first few inches from the surfaces show a slight brownish stain, but no marked decomposition. There are scattered inclusions of micaceous and hornblendic gneisses, the former perhaps derived from the Fordham. For the most part, however, the area consists of Yonkers in quite uniform development, well suited for architectural or general construction purposes. There is some variation of texture which ranges from massive and medium or coarse-grained to finely granular foliated gneiss. The massive type appears in limited quantity. The foliation is in part a result of flowage when the mass was still in a viscous condition. Pegmatitic and aplitic phases of the rock are not infrequent, the two occurring in irregular patches rather than dikes. The pegmatite is distinguished by large red, perthitic feldspars and smoky quartz with more or less graphic intergrowth of the minerals.

The jointing is widely spaced, as a rule, and no difficulty is found in obtaining blocks of any required size. The stone is quarried by drilling and blasting. The rough blocks are used for cyclopean masonry or are dressed to dimensions, while the finer material goes to the crushing plant which has been erected near the quarries. In the spring of 1913, work was in progress at two places.

The average product of the quarries may be described as a grayish or brownish gray gneiss of medium to fine texture. The feldspars range from .5 mm to .3 mm in diameter. The composition is that of a normal biotite granite, with microcline as the chief alkali feldspar. The feldspar and quartz are in nearly equidimensional grains, closely crowded, but not interpenetrating, as in some of the stronger granites. The even granular type seems to break down more readily under the weather than the irregular grained Yonkers, but at this place there is little evidence of physical disintegration.

Physical tests. The Yonkers gneiss from the Dinnan quarry, of probably similar character to the stone in the new quarries, was tested by J. L. Davis, of the New York City Board of Water Supply. Two samples showed: specific gravity 2.64; ratio of absorption .30 per cent and .39 per cent; porosity .87 per cent and 1.01

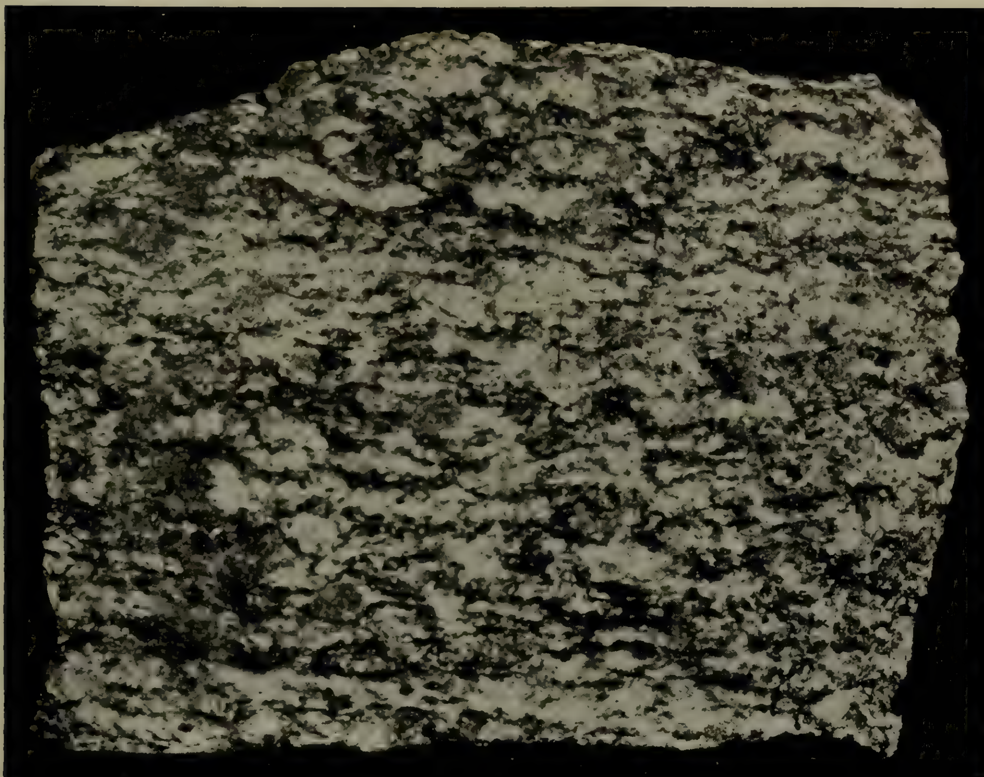
per cent; weight for each cubic foot 163.3 and 161 pounds; percentage of water absorbed .30. The ratio of absorption and porosity are considerably higher than the figures obtained on the Yonkers gneiss of the Hackett quarries, which are given elsewhere.

THE HARRISON DIORITE

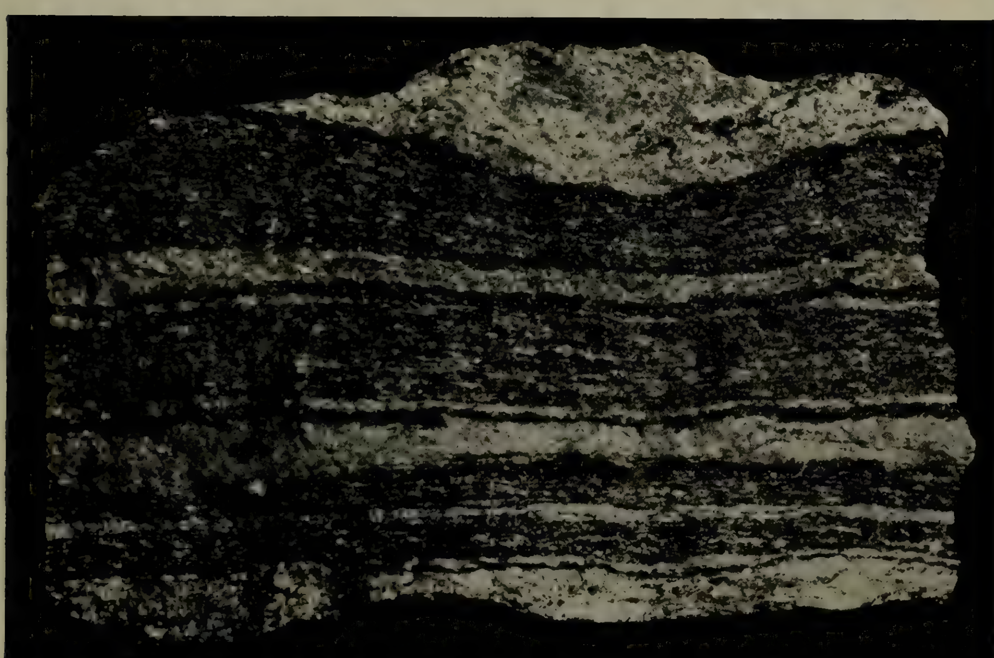
The Harrison diorite covers an area of several square miles within the towns of Mamaroneck, Rye and Harrison, Westchester county. It forms two nearly parallel belts striking northeast and southwest, of which the easterly one extends along the sound from Port Chester to Milton Point and the westerly one, 2 or 3 miles inland, from the Connecticut line to near Larchmont station. The belts are only about a mile wide at most and show intrusive contacts with the Manhattan schist. Across the Connecticut border, they unite with a large area of the same rock that is known there as the Danbury granodiorite.

The rock has a well-marked gneissoid texture, which indicates that it was intruded before the igneous and sedimentary formations of this section were metamorphosed. The date of the intrusion, therefore, is earlier than the period of folding that came at the close of the Paleozoic and later than the Manhattan schist. The diorite resembles in composition the more acid members of the Cortlandt series, but its foliation indicates a separate and prior period of formation, for the Cortlandt rocks are practically unchanged.

Strictly speaking, the rock is a granodiorite, as in its general development, it shows affinity with the granites through the presence of quartz, and considerable alkali-feldspar. The quartz is in fine grains and has a smoky color. The feldspar includes a white plagioclase of andesine to labradorite composition and a nearly colorless microcline. Besides the fine granular feldspar of the groundmass, there are quite frequently porphyritic individuals which have been compressed into lenses or *augen*. These are made up of twin crystals. They measure up to an inch or so long and half that in width, but are more commonly of smaller dimensions. The longer axis and the twinning planes are parallel to the rock foliation. Biotite is the chief ferro-magnesian constituent, but is supplemented by a little hornblende. The biotite is plentiful, in scaly aggregates that interleave the quartz and feldspar. Parallel to the foliation thus produced, the rock breaks more or less readily and the resulting surface is always much darker than the fractures across the foliation. Of smaller importance is garnet which appears in



Harrison diorite, characteristic foliated structure. Quarry Mamaroneck.



Fordham gneiss, banded by lighter granitic material. Dublin quarry, Westchester county.

reddish grains, of irregular form, scattered through the groundmass; the grains are not conspicuous as they are seldom over 5 mm in diameter.

The color of the diorite is dark gray, with a bluish tint. The hammered surface, which is the usual finish, shows lighter and is quite attractive.

Faillace quarry

The quarry operated by Faillace Brothers, of Mamaroneck, is on the north side of the New Haven Railroad, and a little west of the village. It is in the western of the two parallel belts. In the spring of 1912, it was the only active quarry in the diorite.

The quarry is situated on the side of a low ridge, which has a northeasterly trend parallel to the general strike of the country rocks. The face is about 200 feet long, falling to 30 feet at either end. There is no sheet structure, but a system of discontinuous joints, 6 or 8 feet apart, dips at a low angle to the south, parallel to the surface. The principal jointing strikes and dips with the foliation, that is, strikes northeast and dips northwest at an angle of 65°. There are also cross-fractures, but they maintain no regularity.

The rock is a dark, very biotitic variety of the diorite, but rather more uniform in appearance than the average rock, and fairly free of knots or streaks of any kind. It carries porphyritic feldspars, which are usually compressed into lenses, or completely granulated, and which may reach an inch in maximum diameter. The uncrushed individuals show simple twinning after the Carlsbad law. The body of the rock has a fine grain, the quartz and feldspar averaging about 2.5 mm across. Pink garnet is usually present in small scattered granular aggregates that are noticeable but not conspicuous. The rock has a fresh appearance which is confirmed by negative tests for carbonates with dilute hydrochloric acid.

The quarry is equipped with two derricks. There is a crusher for using the waste. The principal product is rough and dressed blocks for building purposes, foundations, walls etc. The dressed material, for the most part, is finished with the patent-hammer. The stone is well suited for practically all purposes that do not require a light color or a fine finish. It is not susceptible, of course, to polishing. The waste is sold for riprap or crushed at the quarries.

Campbell quarry

The Campbell quarry, which is the only one in the vicinity mentioned by Eckel, has not been worked in the last four years. It is

situated along the highway, just north of Larchmont station. As the vicinity is now a residential section, it is doubtful if work will again be started.

The diorite is here massive or slightly foliated, and of lighter color than the average. It shows effects of weathering in iron discoloration and clouding of feldspars. Pegmatitic segregations of the constituents are noticeable in places. The foliation strikes northeast and dips about 55° northwest, conforming to which is the principal joint system.

The product of the quarry is stated to have been about 1000 cubic yards a year, mostly dressed stone.

A quarry, owner unknown, is situated in the interval between the Campbell and Faillace quarries, southwest of Mamaroneck. It was not in operation in the spring of 1913, and apparently had been abandoned for several years. It shows a face 100 feet long on the strike of the diorite and from 20 to 35 feet high, with a width of 50 feet. The structural features resemble those at the Faillace quarry. The rock is a dark gneissoid type, quite uniform as to composition and appearance. Pegmatite in small segregations and stringers is the only variation at all noticeable. There is no equipment on the property. The product seems to have been mainly dimension stone.

THE FORDHAM BANDED GNEISS

The Fordham gneiss is a variable rock, or rather an assemblage of more or less contrasting types, which spread over an extensive area on the east side of the Hudson. It occurs in several belts that follow the general northeasterly structural trend and that have the Harlem river as their approximate southern boundary. In southern Westchester county, it borders the Yonkers on both sides, and a small strip continues along the eastern edge of the main Yonkers area to its northern end. Another belt is exposed along the Hudson from the Harlem river northward, occupying most of the first line of ridges that parallel the river.

The Fordham is a banded gneiss, in which respect it differs from the Yonkers. This banding is caused by variation in mineral composition, the lighter bands having less biotite than the darker ones. Some light bands are made up of nearly pure quartz, but usually there is a large proportion of feldspar. In the main, the rock may be classified as a biotite gneiss, composed of quartz, feldspar and biotite in fluctuating amounts. The feldspars are orthoclase, microcline and an acid plagioclase, the latter having the characteristics usually of oligoclase. The color is grayish and averages darker

than the Yonkers, owing to the larger proportion of biotite. The texture inclines to finely granular, except when injected by coarse granite.

With respect to the other gneisses and igneous rocks of this section, the Fordham occupies a basal position, so that its early Precambric age seems established. It is clearly intruded by the Yonkers. As it is made up largely of sedimentary material, it may be classed as Grenville, which is the position assigned to it by Berkey.

The sedimentary derivation of the gneiss is strongly suggested by the regularity and persistence of the banded structure, which resembles true stratification. Further evidence of this origin is found in the gradation into quartzite that is observable in places, and also by the bands, streaks and irregular masses of calcareous material which are included within the formation. These inclusions become of considerable importance in the northern extent of the Fordham and are seen not infrequently in Westchester county. The banding of the gneiss is referable in greater part to variations in the original sediments which are believed to have been of the nature of impure limestones, shales and shaly sandstones.

Granitic and pegmatitic injections have taken place in parts of the Fordham along the planes of foliation. The igneous material may form thin bands or veins that alternate more or less regularly with the gneiss, with sharp contacts; or it may impregnate the body of the gneiss itself. Occasional dikes of these rocks cut across the bedding.

Physical character and composition. The gneiss is medium to dark gray in color, with a pinkish tone when there is much granitic mixture. The banding is its most striking feature. By reason of the parallel arrangement of the biotite, the dark bands partake of a certain degree of schistosity, cleaving or breaking rather readily along the foliation. The most persistent joints follow the foliation. These are variably spaced, from a few inches apart, where the gneiss has been crumpled or shattered, to several feet in the uncontorted rock.

The texture of the gneiss is fairly even but extremely fine. The diameter of the feldspar particles ranges from .25 to 3 mm, and the quartz is only slightly larger. The feldspar in most places shows incipient kaolinization, but otherwise there is little alteration noticeable. The biotite is somewhat bleached and the iron set free is segregated in the cracks and sutures. Muscovite and hornblende are usually present in small amounts.

An average sample of Fordham gneiss taken from the Nichols quarry, showed a specific gravity of 2.66. The ratio of absorption was .165 per cent and pore space .438 per cent.

Quarry development. There are only a few active quarries in the Fordham belts. The variability and foliated structure of the gneiss operate against its extended use as building material. Still the Dublin and Hastings quarries have furnished considerable building stone, selected from the coarsely jointed ledges, which has given good satisfaction so far as concerns durability. Its principal sale is in rough blocks for foundation work and crushed for concrete and roads. As a road material it is rather inferior, owing to its tendency to split in platy pieces.

There are quarry sites at Uniontown, Bryn Mawr, Lowerre and Fordham, from which no stone has been taken in recent years. The Uniontown quarry, according to Eckel, was worked for rough stone for one of the Warburton avenue bridges. It yielded a contorted gneiss inferior to that worked in the present quarries.

Near Bryn Mawr, two small openings in the Fordham are found on Palmer avenue, near Fort Field reservoir. The eastermost is stated by Eckel to yield a crumpled, poor grade of stone. The westerly opening shows a better quality which is exemplified in the walls and gatehouse of the reservoir. Some of the rock was crushed for macadam.

The Lowerre quarries were opened in 1898. The gneiss here shows granite veinings and is intersected by a pegmatite dike. Rough foundation stone has been the principal product.

The Fordham quarries were situated just south of that place and west of the Harlem railroad. They furnished crushed stone mostly, used for railroad ballast. Their sites are now occupied by buildings.

Reilly quarry

The Reilly quarry, owned and for many years operated by Patrick Reilly, is one of the more prominent ones for the production of building stone. It is situated at Dublin, southwest of Tarrytown, about 1½ miles east of the river. For the last three years the property has been leased to Thomas Murphy of Irvington.

The rock at this place is a hard, banded gray gneiss with a considerable proportion of igneous material. Seams and bunches of granite and pegmatite are common. The foliation and banding strike N. 30° E. and dip 80° southeast. The bedding joints are rather widely spaced, so that thick blocks are obtainable. A hori-

zontal system of joints is present. The quarry was formerly worked in two faces, one 30 feet and the other 50 feet high, but of late years the stone has been taken out without much method. The opening is about 200 feet long and has been extended about an equal distance back from the highway. The stone is hauled to Irvington, a distance of 2 miles, for shipment. It is chiefly sold on contract, so that operations are somewhat irregular.

The principal structures in which the stone from this quarry has entered are the Rockefeller and Archbold residences at Tarrytown.

Duell & Holloway quarry

The firm of Duell & Holloway, of Tarrytown, owns a quarry near Glenville, 2 miles southeast of the former town, which appears to be situated in the Fordham gneiss. The rock is fine grained, grayish and irregularly banded. The darker seams contain abundant biotite and hornblende, the latter more prominent than is usual with this gneiss. The texture is firmly knit, almost like that of granite, and the stone is hard and tough. It shows no marked tendency to split into tabular blocks, as in fact the foliation, so marked in the average Fordham, is quite obscure in the hand specimens from this quarry. The feldspars which are mainly under 2.5 mm diameter, belong mostly to orthoclase and oligoclase, the former cloudy and micasized, and the latter less altered, but showing effects of compression.

The banded structure and foliation strike N. 50° E. and dip about 30° southeast. A system of nearly vertical joints is very closely spaced so as to make the product more suitable for crushing than for building purposes. The horizontal set of joints is less in evidence. Granite seams occur irregularly parallel to the foliation.

The quarry opening extends about 900 feet in the longer direction. There is little method apparent in the operations, as the principal object has been to break down the stone at the least possible expense without reference to the production of dimension material. The output is employed mainly for crushed stone which is sold in the vicinity.

Nichols quarry

The Nichols quarry, situated southeast of Hastings, on the road to Unionville, is a continuation of the old Lefurgy's quarry which at the time of Eckel's report was one of the principal quarries in the Fordham gneiss. The quarry is worked by W. H. Nichols,

of Hastings. The opening extends about 300 feet on the strike of the gneiss, which is nearly north and south; it is about 100 feet wide and the face on the west side about 30 feet. The quality of the rock exposed in the quarry is somewhat variable. The best quality is found in the west side where a massive gray gneiss is quarried for building stone, in blocks that measure up to 10 feet long and 4 to 6 feet in section. Through the middle of the quarry runs a band about 18 feet wide of a darker, seamed, or contorted gneiss. There is more or less granitic admixture with the gneiss, but this is not usually injurious to the strength or appearance of the stone.

Besides the bedding joints that run with the foliation and dip 80° east, there are two well-developed sets at right angles to the foliation, the one dipping 80° south and the other 35° north.

Microscopic examination of the gneiss from this quarry shows the mineral composition to be like that described for the typical Fordham. The texture is even grained for the most part, and very fine, with indistinct banding. The feldspar and quartz particles average under 1.5 mm and the biotite scales are of about the same diameter. There is only an occasional shred of hornblende. Among the accessory constituents is zoisite in small rounded grains. Sulphides are absent. The only mark of alteration is a slight clouding of the feldspar, due to incipient kaolinization. The specimens showed no effervescence with muriatic acid.

A hand derrick and steam drill comprise the quarry equipment. The blocks are loosened from the ledge by drilling deep holes and loading with black powder, after which they are broken up by hand drilling. The stone is sold rough and dressed for building and foundation work. The waste is sold as crushed stone for macadam.

Fenano quarry

A quarry in Tuckahoe has been operated for several years past by Nicholas Fenano. The rock is a compact bluish or grayish gneiss of the Fordham type, but somewhat contorted and broken by numerous joints. The opening is about 200 feet long on the strike of the gneiss and shows a face of 40 feet. The strike of the beds is north and south and the dip vertical. Most of the product has been sold as crushed stone, the larger blocks only being utilized for foundation or building work. The ledge has been worked nearly down to the street level and it is probable that the quarry will soon be converted to other use.

THE MANHATTAN SCHIST

The Manhattan schist which underlies the island of Manhattan and extends northward into the Bronx and Westchester county has no great importance as a quarry stone. Its foliation, variable composition and thinly jointed character are against its general use for architectural purposes or for cut stone, though it has been employed quite extensively for walls and rough masonry where readily available. In a few places, specially in the vicinity of plutonic intrusives which have invaded and injected the schist, thereby rendering it more massive and compact, it has found some sale for building stone.

The schist, like the Fordham gneiss, is a metamorphosed sediment; in its original form probably a shale. In the field there is a close resemblance between the two, though stratigraphically they are separated by both the Lowerre quartzite and the Inwood limestone. A comparison of typical samples of the schist and gneiss shows, however, that the former is more micaceous and carries less of the feldspars than the Fordham. The mica in both is mostly biotite, but in the Manhattan schist there is also considerable muscovite. The feldspathic constituents are generally subordinate to the quartz.

The color of the Manhattan schist is gray, medium to dark, the lightest being the injected phases. Foliation is marked, owing to the abundance of mica, and follows apparently the original stratification. Crumpled and thin-jointed types are common.

The schist is intruded by dikes and small bosses of granite and occasionally of diorite and more basic rocks. In their vicinity, but especially near the granitic intrusives, it is likely to change considerably in appearance and composition. Through the injection by granite, it develops into a feldspathic rock which resembles a banded gneiss or, when the schist is more thoroughly absorbed, it becomes fairly uniform and quite massive, not unlike the granite itself. Such mixed phases are too numerous to require separate mention. Merrill has noted their occurrence also in connection with the diorite intrusions north and east of New Rochelle.

Besides mica, quartz and feldspar, the schist contains a number of accessory minerals like garnet, sillimanite, titanite and magnetite. The texture is generally fine, even granular, but may become porphyritic near igneous contacts through the development of large feldspars. The rock possesses no features that are objectionable to its general employment for construction purposes, except its somewhat variable appearance and foliation. The mica

which is in the scales arranged parallel to the foliation makes it readily cleavable and is a source of weakness if proper care is not used in laying the stone. It should not be placed, of course, on edge, as the effects of water and frost are greatly accentuated if the foliation is thus exposed.

There are no permanent quarries in the Manhattan schist. Most use of this stone has been made in foundation and retaining walls on Manhattan island and much of the material has been taken from excavations on building sites. The local operations, therefore, do not call for special mention.

GRANITE NEAR RAMAPO, ROCKLAND COUNTY

The belt of Precambric gneisses which enters southwestern Rockland county from New Jersey, forming the massive ridges of the Ramapo mountains, contains several quarries around Suffern and Ramapo which have supplied building stone for local uses and to some extent for shipment. The gneisses are pink or gray and carry hornblende or biotite as the iron-magnesia mineral. In general composition they resemble granite, being composed mainly of acid feldspar and quartz. They range from foliate, thinly bedded types to heavily jointed massive examples. The latter, of course, are better adapted for all constructional work, in which they take the place of true granite. They are intersected by vertical joints of which there is usually a system running nearly north-south and a second at about right angles.

The quarry sites are situated along the Erie Railroad between Suffern and Ramapo. One of the principal openings, but idle for many years, lies on the ridge south of Ramapo and west of the railroad tracks. The rock is a hornblende gneiss of massive character, reddish in color. Smock mentions the quarry as having furnished building and monumental stone, as well as material for many of the Erie Railroad bridges.

A quarry near Hillburn was worked by Rice Brothers up to the year 1904. The output consisted of building, monumental and rough stone.

GRANITE AND GNEISS IN ORANGE COUNTY

Several granite intrusions are found in the southwestern part of Orange county, near the New Jersey state line. Two of these constitute rather large bosses that rise into the conspicuous twin peaks Mounts Adam and Eve, at the edge of the " Drowned Lands "

of the Wallkill river. Both are made up of a coarse hornblende granite, somewhat gneissoid in places and showing pegmatitic and aplitic variations. Mount Eve, the larger boss, occupies an area about 2 miles long and a mile wide. Mount Adam is a nearly round mass, about one-half of a mile in diameter. There are small knobs of the same granite near Big island, just northeast of Mount Eve and also in the section southwest, along the general axis of the main intrusion.

Pochuck mountain, a broad ridge which lies principally in New Jersey, consists of Precambric gneiss broken here and there by granite. On the northeastern end, the part within New York State, the easterly slopes are formed by a coarse, quite massive, hornblende granite, but the western half is made up of biotite gneiss. The granite is lighter in color than that just mentioned but its mineral composition is similar and it may be of related origin.

The section of the Highlands in the vicinity of these intrusions possesses much interest to the geologist. The contact zones between the granites and the bordering limestones are especially notable and have long been a favorite collecting ground from which much material has found its way into museums. The geological features of this section are set forth in numerous papers and reports, the more recent being those by Kemp and Hollick [1] and by Ries.[2]

Quarries on Mount Adam and Mount Eve

Practically the same kind of granite is exposed on the two knobs, Mount Adam and Mount Eve, and they belong no doubt to a single intrusion, though separated by a belt of crystalline limestone. Mount Eve, the larger knob, rises to an altitude of 1057 feet above sea level; its greatest axis in the direction northeast-southwest is about 2 miles. Mount Adam, which is really a spur on its western flank, measures little more than one-half of a mile in diameter, with a summit about 100 feet below that of Mount Eve. Smaller knobs of the granite are found at Big island, just north of Mount Eve and on the eastern and southern borders of the mountain.

The granite resembles that from Pochuck mountain in general character and composition. It belongs to the hornblende granites,

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[1] The Granite at Mounts Adam and Eve and Its Contact Phenomena, N. Y. Acad. Sci. Annals VII, 638.

[2] Report on the Geology of Orange County, N. Y. State Museum Rep't 49, 2, 1895.

but contains some biotite. It has a coarse texture, as seen at the quarries, and in color is a medium gray with bluish or greenish tints which arise from the variable appearance of the feldspar crystals. These measure from 5 to 15 mm in diameter. Though generally massive, the granite shows local phases characterized by a parallel or gneissic arrangement of the constituents, as is well exhibited on the north side of Mount Eve. Pegmatitic variations are rather frequent, especially on Mount Adam, where also the normal, coarse, grayish granite gives way in places to a finer grained and much darker dioritic rock. This lack of uniformity constitutes a serious drawback to the opening of quarries in many parts of the exposures.

The quarry localities are on the north slope of Mount Adam and the western slope of Mount Eve. The Mount Adam quarry, according to Smock, was opened in 1889 by the Mount Adam Granite Co. of Middletown. It has long since been abandoned. The workings have a total length of 250 feet and a face from 20 to 30 feet high. There are two grades of rock exposed, the one consisting of the usual coarse hornblende granite, and the other of finer grain with little hornblende, forming streaks and patches in the first. Feldspathic and pegmatitic seams are present. The jointing is divided into three systems. Two strike north-south and dip about 70° in opposite directions, the third strikes N. 45° E. and dips 55° southeast. No equipment is found on the property. The quarry lies about one-half of a mile north of the railroad to which the stone was formerly hauled over a private road.

The Mount Eve quarries were opened about 1890, at the same time as those on Pochuck mountain and by the same company. They are situated a little way up the western slope, in the notch between the two knobs. They have likewise been abandoned and the equipment removed from the property. The granite is less broken than on Mount Adam and shows more uniformity of character. It was worked quite extensively for dimension stone which was shipped to Orange, N. J., and other places. The workings at present are so heavily overgrown with bushes as scarcely to permit inspection. The nearest point of shipment on the railroad is about 1½ miles distant.

Microscopic characters. The petrography of the granite is described in detail in the paper by Kemp and Hollick, already cited, from which the following information is abstracted. The principal dark mineral is hornblende, but there is more or less biotite

associated with it, as well as some pyroxene. The feldspars include orthoclase, microcline and microperthite among the alkali varieties. Plagioclase is represented in amount quite equal to the others, so that the composition approaches a diorite. The quartz carries abundant inclusions but otherwise is not especially remarkable. Less important constituents are titanite, zircon, magnetite and allanite, the last being quite common in the granite from both quarries.

Pochuck Mountain quarries

The principal quarry working in the Pochuck granite area is situated just north of the State boundary and on the east side of the mountain. It is reached by the branch railroad that connects Pine Island on the main line with Glenwood, N. J. It was opened about 1890. The property was developed and worked by the Empire State Granite Co., but has been inoperative for the last four or five years. Building stone and paving blocks were quarried. Among the structures in which the granite has been used are the post office and the Hinchcliffe brewery at Patterson, N. J.

The quarry is opened for a distance of 200 feet along the mountain and has a face from 30 to 40 feet high. The excavation is insufficient to show the general rock structures. There appears, however, to be no well-defined sheeting.

A second smaller quarry has been opened a little south of this property, but is also idle at present. It belongs to P. J. Carlin of New York City. The granite is of the same general character as that in the Empire State quarry.

The granite from this locality has a coarse texture, varying from massive to slightly foliate, and a pink body that is mottled with gray and black. The general color effect is pinkish gray of medium shade. The feldspars measure about 10 mm and the black aggregates of hornblende and biotite from 5 to 10 mm in diameter. The granite in hand specimen shows no weathering or discoloration.

Microscopic examination. The feldspars, which are the most prominent constituents, include microcline, microperthite and orthoclase of pink color and a whitish soda-lime variety, all in practically unaltered state though somewhat fractured by compression. Quartz is next in amount. The hornblende greatly predominates over biotite and is a strongly pleochroic, dark green to brown variety, showing slight chloritization. Large crystals of titanite are included in the dark aggregates of hornblende and biotite. Zircon, apatite, magnetite and biotite are present in small quantity. The absence of carbonates is indicated by hydrochloric acid tests.

Chemical analysis. The following analysis was reported by the Empire State Granite Co. in reply to a request from the State Museum dated in 1904. The analysis was made in the laboratories of Simonds & Wainwright of New York:

SiO_2	66.12
Al_2O_3	13.71
Fe_2O_3 } FeO	6.42
MgO	1.15
CaO	3.45
Na_2O	3.61
K_2O	4.31
H_2O	.87
S	.07
MnO	tr
	99.71

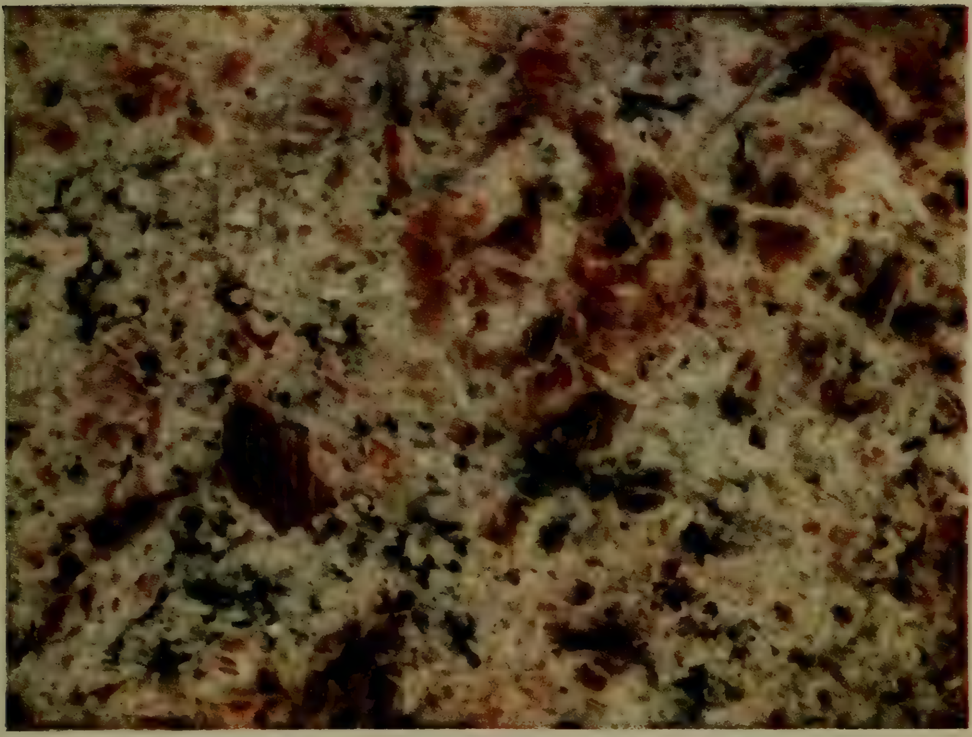
Physical tests. Compression tests of the granites from this quarry, made by Prof. P. J. Carlin, showed an ultimate strength of 23,500 pounds to the square inch in one sample and 22,900 pounds in a second sample. Gravity and absorption tests by the writer gave: Specific gravity, 2.74; ratio of absorption, .148 per cent; pore space .402 per cent.

West Point gneiss quarries

The notable collection of buildings at West Point affords an example of the architectural use of local stone to good advantage, an example that might be profitably followed more frequently perhaps than is usual in this section, although there are not a few instances of the adaptation of native quarry materials to be found in the Highland region. The larger structures at West Point, including the new chapel, the power plant, riding hall and several others, are built of dark gray gneiss that is found on the side of the ridge to the west of the academy grounds. The quarries are worked only as the need develops from time to time, being used only to supply the local requirements. There are several openings, but the principal one from which building stone has been quarried of late years is near the north end of the ridge and somewhat above the main level of the academy site. The gneiss is quite fresh at the surface which shows the effects of glacial erosion in deep scorings and polished surfaces. It is a coarsely jointed biotite gneiss, veined and broken by a more massive granite. The two rocks vary much in proportion from place to place and there is every gradation between

Plate 22

Porphyritic granite. Horicon, Warren county



Pegmatitic granite. Orange county

the thinly foliate gneiss and the massive granite. Within the limits of one quarry, however, material is found that is fairly uniform. It fills all the requirements for rock faced ashlar, as it is strong, durable and quite attractive if somewhat somber of tone.

Pegmatitic granite in Orange county

Within the Precambric belt of Orange county, which includes most of the Highlands area west of the Hudson river, occur numerous outcrops of coarse, reddish granite of pegmatitic nature. This rock is differentiated from the surrounding gneisses that form the main mass of the Highlands by its coarser grain and also by its more massive appearance, never showing the well-developed parallel arrangement characteristic of the latter. The feldspars reach a diameter of an inch or even more when uncrushed, and are inclosed in a finer mixture of granular feldspar and quartz, so as to lend the aspect of a porphyritic rock. The feldspar in the groundmass is the result largely of the breaking down of the larger individuals under compression, the uncrushed remnants having a rounded or lenticular cross-section. The predominant variety is red microcline, but there is also more or less of white or greenish plagioclase. Of dark silicates the rock carries very little ordinarily. On the other hand, magnetite is a common ingredient, and epidote appears quite often as an alteration product. By reason of the varied colors imparted by the feldspar, magnetite and epidote the granite not infrequently possesses ornamental qualities which make it serviceable for decorative work and it has been employed locally for that purpose in fireplaces, mantels etc. Unfortunately it does not occur in large enough bodies to be quarried on a commercial scale.

The granite may be seen in the form of stringers, dikes and irregular bodies which intersect the gneiss and are probably offshoots of some magma that has penetrated the country rocks from below at a time when the metamorphism of the latter had been completed. The same magma is possibly represented in the bosses of granite outcropping on Mount Adam, Mount Eve and Pochuck mountain in southern Orange county. The magnetite mines are situated mainly in belts of gneiss that have been injected by the granite, and afford good specimens of the fresh material. At the Forest of Dean mine back of West Point a very attractive variety occurs in contact with the magnetite, and there is a large amount of it on the mine dump.

THE DARK COLORED, BASIC ROCKS

BASIC ROCKS IN THE ADIRONDACKS

Traps or diabase dikes occur in great numbers in the main Adirondack region, though they are very unequally distributed. They occur with greatest frequency in the eastern and northern parts, embraced in Essex, southwestern Clinton and southern Franklin counties. As they were intruded during the Precambric they are not found outside the area underlain by the crystalline formations — the gneisses, schists, crystalline limestones and plutonic igneous masses; but they may be looked for in any of the rocks just named.

The Precambric area of Essex and Clinton counties includes numerous examples of the dikes, so many that their separate occurrence has hardly seemed worthy of note in the geological reports dealing with this section. They are particularly in evidence in the vicinity of the iron mines at Hammondville, Mineville, Ausable Forks, Lyon Mountain and in the Saranac valley; but are probably no more frequent there than elsewhere in the same region; they are simply better exposed. The writer has noted more than a hundred such dikes in these districts. They all present very similar features of physical development, consisting typically of feldspar, pyroxene and magnetite with the peculiar diabase texture which arises from the inclusion of the pyroxene within the meshes formed by the interlacing feldspar laths. As a rule they are fairly fresh at the surface and give a metallic ring when struck with the hammer. They have the tabular form characteristic of fissure intrusions and are seldom more than a few feet thick though persistent on the line of strike. Their prevailing direction is from north to northeast in conformity with the main structural trend of the inclosing rocks. The trap is well suited for road material on account of its toughness and wearing qualities, but the occurrences so far discovered are scarcely of sufficient size to justify quarry work. Dikes over 15 feet thick are very rare and of those seen by the writer a thickness of 30 or 40 feet represents about the maximum. They have a steep dip, usually nearly vertical, so that their quarrying would be difficult and relatively expensive.

A more available material for local road building in the Adirondacks is found in the areas of gabbro and basic syenite. The latter, normally a feldspathic rock, develops in places into a very dark material with abundant iron-magnesia minerals and magnetite, which closely resembles and even grades into the gabbros. The

latter are almost identical in mineral composition with the diabase trap. Like these they are very tough resistant rocks, but normally are coarser grained and consequently would not wear so evenly under abrasive conditions. The gabbros occur in dikes, larger than those in which the diabase is found, but more frequently they form rounded and irregular masses or stocks from a few hundred square feet to several acres and even miles in area. They are very common in Essex county within the Lake Champlain drainage area where their occurrence in part is well shown on the Elizabethtown-Port Henry geologic sheet.[1]

The texture of the gabbros and syenites varies from coarse to fine, the finer sorts being on the borders of the areas, where the magmas were subject to quick chill. In these border places are to be found the most suitable material for crushed stone. Some of the gabbros exhibit textures very similar to the trap, their feldspar being in lath-shaped crystals which form a network that incloses the pyroxene in the meshes. Such border phases are practically equivalent to the diabases and should prove equally serviceable as materials for crushed stone of the best quality.

Numerous chemical analyses of the Adirondack traps, gabbros and syenites have been published in the geologic reports of this region.[2]

LITTLE FALLS, HERKIMER COUNTY

An outlier of the Adirondack crystalline rocks occurs in the Mohawk valley at Little Falls where quarries for the supply of crushed stone and, to a smaller extent, of building material have been operated for many years. The situation is very advantageous for extraction and marketing of stone as the area is crossed by two main railroad lines and the Erie canal, and there are bare rock ledges close at hand which afford good quarry sites. The rocks are principally adapted for road, concrete and foundation work, being rather dark for use in buildings. They include a fine-grained syenite which occupies most of the area, reddish granite and trap, the last occurring in a dike over 100 feet wide — the largest known in the southern Adirondacks.

The Little Falls outlier has been mapped and described by H. P. Cushing in connection with his report on the "Geology of the Little Falls Quadrangle" (N. Y. State Museum Bulletin 77). It consists of a single area of these Precambric crystallines that outcrops within

[1] Included in N. Y. State Mus. Bul. 138.
[2] See especially Museum bulletins 95 and 138.

the gorge of the Mohawk at that place and extends eastward for nearly 2 miles; the syenite forms the first lines of cliffs on either side, rising to a maximum of about 200 feet above the river, above which is a second steep scarp consisting of the exposed edges of Ordovician limestones whose base rests unconformably upon the crystallines.

The Little Falls syenite has a dark green to nearly black color, changing to yellowish or brownish on weathered surfaces. The texture is mostly fine granular, the result of mashing after intrusion. There are occasional feldspar "augen" in the midst of the comminuted minerals which may be taken as evidence that it once possessed a much coarser grain. Over much of the area it has a mashed gneissoid appearance and is thinly jointed, the joints causing a platy structure in places like that of a schist. There has been some infiltration of iron oxides along the joints and locally these extend into the body of the rock, filling the minute cracks and pore spaces and changing the color to a brick red.

In composition, the rock varies considerably from place to place and in many samples of the outcropping portion shows a wide departure from the syenitic type. In the eastern section, the mass develops very dark basic phases which are close to gabbro in mineral composition and in the hand specimen much resemble a fine-grained gabbro. Such phases occur along the tracks of the Dolgeville railroad, near the quarries of the Syenite Trap Rock Co. The feldspar constituents, however, belong to the alkali varieties, with subordinate amounts of lime-soda feldspar of andesine or oligoclase type, so that the material can not be classed as gabbro. Quartz is also present, as it is elsewhere in considerable abundance. The dark minerals include hornblende, hypersthene, biotite and garnet. Among minor ingredients are apatite, quartz, titanite, magnetite and pyrite. In the more acid phases, there is about 75 per cent of feldspar, chiefly microperthite, about 10 per cent of quartz and between 10 and 15 per cent of the iron-magnesia minerals. The basic examples carry as much as 50 per cent of the latter ingredients.

Throughout the exposure occur scattered patches and bodies of a reddish granitic rock, some of which seem to be in the nature of inclusions, rather than dikes. Such are found in the north face of the Trap Rock Company's quarry. Cushing regards the red granite found in the western section around Little Falls as intrusive in the syenite.

Chemical analysis. The following is an analysis of the Little Falls syenite extracted from N. Y. State Museum Bulletin 115, the analyst being E. W. Morley:

SiO_2	66.72
Al_2O_3	16.15
Fe_2O_3	1.23
FeO	2.19
MgO	.73
CaO	2.30
Na_2O	4.36
K_2O	5.66
H_2O	.77
MnO	.07
	100.18

The analysis is undoubtedly based on samples of the more quartzose rock.

Physical tests. Numerous tests of the Little Falls syenite have been made by the bureau of research, State Department of Highways. The following table gives the maximum and minimum and average results of eleven different tests:

	Maximum	Minimum	Average
Specific gravity	2.93	2.75	2.80
Weight pounds for each cubic foot	183	172	175
Absorption, pounds for each cubic foot	.21	.09	.15
Per cent of wear	4	2.6	3.3
Hardness	18.4	17.8	18.1
Toughness	14	8.5	11.7

Diabase dike. The dike that has been mentioned as intersecting the syenite is found in a slight depression of the surface about 1000 feet west of the Syenite Trap Rock quarry. It shows also in the face of the cliffs above the Dolgeville railroad cut and can be traced thence northeasterly toward the Little Falls road, but is concealed near the road itself if it reaches that far. The dike has been intruded along the course of the main jointing which here is N. 30° E.; the map in Cushing's bulletin, however, indicates the strike as nearly east and west. Within the exposed section, it measures about 125 feet in width, which may be taken as about the actual thickness. It thus could be quarried without difficulty. It ranges from very fine, even, glassy texture near the contact to a rather coarse grain with porphyritic feldspars an inch or so long in the interior of the body. Though somewhat altered in the outcrop, pieces give a metallic ring when struck, like a hard trap. Its mineral composition may be described as consisting of plagioclase, augite and magnetite, with secondary serpentine and chlorite.

Syenite Trap Rock Company's quarry

The Syenite Trap Company's quarry is situated 1½ miles east of Little Falls on the north side of the river and New York Central tracks. It was opened about ten years ago on an extensive scale for the purpose of supplying crushed stone for highway, canal and railroad construction. The present quarry cut is nearly 1500 feet long with a face of about 60 feet as a maximum. The stone is quite massive in appearance and is less broken by joints than in most of the exposure. It is extremely tough and resistant in the quarry, showing qualities that fit it for heavy service. The crushing plant is built on the side of the cliffs, the stone passing through the successive crushers and screens by gravity into the storage bin from which it can be loaded directly into cars. The plant has a capacity of from 800 to 1000 tons a day.

An interesting feature, though of some inconvenience to quarry operations, is the presence of numerous pot holes, both on top and side of the syenite cliffs, which attain a diameter of 30 or 40 feet in some instances. They are filled with transported boulders and pebbles of various rocks, many beautifully rounded and polished. They occur up to 200 feet nearly above the bed of the present river. A pot hole about 70 feet in diameter was encountered in the excavation for the new locks at Little Falls.

Little Falls Stone Company's quarry

The site of the Little Falls Stone Company's quarry is on the south side of the Mohawk, opposite the quarries just described. The syenite is exposed as a ledge for a distance of 800 feet in an east-west direction, with a face about 50 feet high in the center, sloping off somewhat toward either end. The rock is rather variable in structure, ranging from a platy schistose type, badly broken up, to a massive, heavily jointed material that has no definite cleavage. The quarry was opened for the supply of crushed stone for cement blocks. A large plant was erected near the quarry for making blocks, but has not been operated for the last four years and the quarries also have been idle during that time.

GREENFIELD, SARATOGA COUNTY

The Saratoga Trap Rock Co. has a quarry in the town of Greenfield, 3 miles northwest of Saratoga Springs. The rock is a fine-grained diabase, occurring in a dike which strikes N. 20° E. and extends across the line of the Delaware and Hudson Railroad

Plate 23

Quarry and crushing plant of the Little Falls Stone Company. Quarry is partly hidden by the trees, but can be seen at extreme left.

(Adirondack branch). The dike is notable for its continuity along the strike, although its thickness is nowhere very great, being about 60 feet from wall to wall in the quarry opening. It can be traced northward beyond the railroad by occasional exposures for over one-half of a mile and finally branches into two or three smaller dikes. The section south of the railroad is fully as long. The dike stands nearly vertical and cuts through a garnetiferous schist. The openings are just south of the railroad and east of the north-south highway. An examination of the diabase under the microscope shows that the mineral constituents are pyroxene, feldspar and magnetite in the order of their importance. The minerals are somewhat decomposed by weathering, though in hand specimen the rock appears hard and has a metallic ring.

FORT ANN, WASHINGTON COUNTY

Several dikes of trap are found on the ridge east of the canal, near Fort Ann. They are of small size, though their occurrence so near shipping facilities has given them economic interest and led to active quarrying in one case. The Champlain Stone and Sand Co. operated a crushing plant for a short time about 1907. The dikes are the usual diabase, with pyroxene, feldspar and magnetite as the principal constituents. Specimens examined by the writer showed slight decomposition but not sufficient probably to affect materially the wearing quality of the stone for road uses.

THE CORTLANDT BASIC ROCKS

A great boss of igneous rocks, mainly of the dark basic kinds, is found in northern Westchester county, just south of Peekskill. It covers a large part of the town of Cortlandt, having an area of about 25 square miles, rounded in outline and extending along the Hudson river for some distance on its western border. The intrusion has been described at length by J. D. Dana and G. H. Williams. More recently G. Sherburne Rogers[1] has published a very detailed account of the geology and petrography of the rock series, with many chemical analyses and a map showing the distribution of the different types.

According to Rogers's investigations, the intrusives consist of a complex of rocks of which the largest element is the norites, but including also gabbro, pyroxenite, peridotite, hornblendite, dior-

[1] Geology of the Cortlandt Series and Its Emery Deposits. N. Y. Acad. Sci. Annals, v. xxi, 1911.

ite and syenite. The various rock types are the differentiated products of a basic magma which was intruded in late Paleozoic time. It is thought that the Mohegan granite may represent the acid extreme of the series, although occupying a rather isolated position to the northeast of the basic intrusives. At any rate the granite has the same relations to the surrounding formations which consist principally of Manhattan schist.

There are no active quarries within the area and the only mineral product now worked is emery, which is found in small lenses and pockets near the borders. The rocks are too heavy and dark in color for building stone. It would appear, however, from observations by the writer that there are numerous opportunities for the quarrying of road material of good quality. The fine-grained gabbros and norites particularly seem well adapted for the purpose, being closely knit, tough materials, very similar to diabase in their composition. The best ledges, however, are found in the interior at some distance from the railroad and the Hudson river. The rocks in places are quite heavily charged with pyritic minerals as indicated by their rapid weathering with the formation of a reddish clayey soil. The pyritic zones are probably localized and do not seriously affect the quality of the material as a whole.

Analyses of representative types of the Cortlandt gabbros and norites are given herewith. No. 1 is gabbro, southeast of Salt Hill, H. T. Vulte, analyst. No. 2 is norite, 1½ miles south of Peekskill. S. S. Rogers, analyst.

	1	2
SiO_2	54.72	51.49
Al_2O_3	17.79	20.72
Fe_2O_3	2.08	1.80
FeO	6.03	7.28
MgO	5.85	3.82
CaO	6.84	6.71
Na_2O	3.02	3.70
K_2O	3.01	2.14
H_2O+	......	.31
H_2O-	......	.10
CO_2	......	trace
TiO_2	......	2.26
P_2O_5	......	.15
S	......	.11
MnO	......	.13
	99.34	100.72

Fig. 12 Map of the trap outcrops in Rockland county, after Kümmel. 1, Suffern; 2, West Nyack; 3, Mt Ivy; 4 Rockland lake; 5, Nyack; 6, Haverstraw quarry sites.

PALISADES DIABASE, ROCKLAND COUNTY

The Palisades of the Hudson are the outcropping edge of an intrusion of diabase or trap, the largest anywhere in the State and, by reason of its accesible position, the most valuable for the production of crushed stone. The intrusion altogether is some 60 or 70 miles long north and south, and its width within the Rockland county section ranges from one-eighth of a mile to over 2 miles.

The diabase is in the form of a sheet which has ascended along the inclined beds of Triassic sandstone and shale. The dip of the beds is toward the west and northwest at an angle of from 5° to 15°. In this direction the diabase soon disappears and becomes buried under an increasing burden of sediments. The thickness of the sheet is several hundred feet at least and in places may be around 1000 feet. Although it follows in general the bedding of the stratified rocks, it is observed in places to cut diagonally across the beds for greater or less distances.

The trap exposure follows the shore line of the Hudson quite closely from the New Jersey state line to Haverstraw. Here the outcrop swings around to the west away from the river and after continuing in that direction for some 4 miles, thins out or disappears beneath the surface. In this part the sheet apparently cuts across the bedded rocks at nearly right angles to their strike. The exposure has been described and mapped very accurately by H. B. Kümmel.[1]

The diabase varies more or less in texture from place to place, but has a very uniform composition in which plagioclase, augite and magnetite are predominant and olivine, pyrite, quartz and other minerals are of minor importance. It is grayish to dark green in color, and shows very little alteration. The grain is moderately coarse, except near the upper and lower edges, where it is fine and compact.

For many years the diabase has been extensively quarried for crushed stone. It has also been worked to a limited extent for paving blocks and for building material, but the difficulty of cutting it has prevented any marked development of these uses. As a road metal it has long been recognized as the standard of quality. The quarries around Haverstraw, Rockland lake and Nyack in recent years have had an output annually of over 1,000,000 cubic yards of crushed stone.

[1] N. Y. State Museum Annual Rep't 52, v. 2, 1900.

Tests of the trap by the bureau of research, State Department of Highways, gave the following results on a number of samples:

	1	2	3	4	5	6	7	8
Specific gravity	2.96	2.97	2.88	2.81	2.92	2.96	2.98	2.82
Weight, pounds for each cubic foot	185	186	180	176	183	185	186	176
Water absorbed, pounds for each cubic foot	.68	.17	.40	.44	.26	.22	.23	.70
Per cent of wear	3.6	2.6	2.7	2.1	2.6	3.1	2.8	4.
Hardness	17.8	17.9	17.8	18.6	18.2	17.8	18.2	18.2
Toughness	14.5	17	16.5	22.5	17	16	22.5	14.5

In the near future the quarrying of trap from the face of the Palisades will probably be discontinued, as the river front is to be incorporated in the Palisades Interstate Park.

The property of the Manhattan Trap Rock Co., on the southeasterly face of Hook mountain, has already been taken over for purposes of the park and the crushing plant dismantled. The other quarries in this section are owned by the Rockland Lake Trap Co., the Clinton Point Stone Co. and the Haverstraw Crushed Stone Co. They are still operative (1914) but it is understood that negotiations for their purchase have been begun. With their acquisition the industry along the riverside, which is the most advantageously situated for the economic production and shipment of crushed trap will come to a definite end. The supply then must come from some of the inland quarries or from the New Jersey and Connecticut trap areas, in either case probably at an increase in cost.

The present quarries are well equipped and capable of turning out a large output at a low cost. The largest of them is owned by the Rockland Lake Trap Co., where there is a face of 2000 feet and 500 feet or more high. The rock is broken down in enormous quantity by drilling and blasting, loaded onto cars by steam shovels and crushed in the plants at the riverside whence it is loaded into barges for transport to New York and the other markets on the river and coast.

LADENTOWN, ROCKLAND COUNTY

Trap is exposed over a considerable area south of Ladentown and west of the branch railroad from Spring Valley to Haverstraw. The area is in line with the course of the Palisades intrusion from Haverstraw to Mount Ivy but is separated from the latter by a stretch of over a mile in which the rock does not appear at the surface. The trap also differs somewhat in appearance from the Palisades diabase. As mapped by Kümmel, the area measures

about 2 miles in maximum diameter from northeast to southwest and is about 1 mile wide. It is thus sufficiently large to permit the location of many quarries within its bounds, although as yet undeveloped. The rock is very fine-grained and is somewhat vesicular in places; it may be a surface development of the Palisades diabase.

SUFFERN, ROCKLAND COUNTY

Union Hill, near Suffern, consists of a mass of trap from one-fourth to one-half of a mile in diameter. The rock is a fine-grained, compact diabase of the same composition as the Palisades rock. The Ramapo Trap Rock Co. has opened quarries in the exposure for the production of crushed stone.

PORT RICHMOND, RICHMOND COUNTY

The southern end of the Palisades diabase is found on Staten Island where the intrusion forms a low ridge that extends south-southwest from Port Richmond. The exact limits of the area are not well marked, but it probably is from one-fourth to one-half of a mile wide and terminates somewhere near Linoleumville. Quarries have been opened at Graniteville and Port Richmond. For the last few years they have been inactive.

Section 5

THE OCCURRENCE OF PEGMATITE IN NEW YORK

GENERAL FEATURES, FIELD RELATIONS AND USES OF PEGMATITES

The coarsely textured modifications of granite that are called pegmatites have a special interest that seems best to recognize here by their separate description. This interest is connected not only with their scientific features in regard to origin, methods of occurrence and mineral contents, but also with their industrial uses which cover certain fields quite apart from those belonging to ordinary granites. Pegmatites are sources of feldspar, quartz and other minerals of commercial importance.

The most striking physical character of pegmatites — their coarseness of texture — is a relative one, but important in determining their utility. Almost every variation may be found in the field between the coarser granites which are available for constructional or ornamental stone to the coarsest " giant " granites or pegmatites in which the individual minerals attain dimensions of several feet and weights of a ton or more. It is evident that other things being equal, the larger the size of the crystals, the more readily can their separation be carried out, and ease of separation is an important factor in the success of quarry operations for the production of feldspar and quartz.

Pegmatite is commonly associated with granite in its field occurrence. It is rare enough to find any large granite exposure without more or less of pegmatite either as included bodies or as distinct but apparently related intrusions in the surrounding country. The relation is so constant as to lead to the view already expressed earlier in this report that pegmatite is really but a modified form of granite, the textural differences being ascribable to variations in the process of crystallization. The presence in pegmatites of minerals containing fluorine, chlorine, boron, water, and other ingredients that are regarded as powerful solvents or " mineralizers," is significant. It appears very probable from this and other considerations that the rock represents the residue of a granite magma that was still held liquid after the main body had reached its consolidation temperature. This residue would tend to gather in the lower part of the magma as a result of the forcing out of the solvents from the cooling and crystallizing zone above. With the solvent vapors,

some of the silica, alkalies etc., would be retained in a condition facilitating their ready migration through any favorable channels that might be formed by the fracturing of the overlying rocks. The formation of pegmatite dikes is thus a normal after-effect of an igneous intrusion. As regards their mineral nature, there seems to be a gradation from a composition about that of granite to very quartzose phases and even to pure quartz. The occurrence of many quartz veins in the vicinity of granite intrusions may thus be explained.

Forms of pegmatite bodies. Pegmatite intrusions commonly occur in tabular masses which are called dikes when they occupy vertical or highly inclined fissures, or sills if they follow channels in a nearly horizontal plane. Their direction is determined by lines of structural weakness in the country rock, such as faulting, jointing and in the case of sediments oftentimes by bedding, whichever structure may afford the easiest outlet toward the surface. Dikes and sills are sharply defined in contact with the country rocks. Though exceedingly numerous in the vicinity of granite masses, they only rarely attain a workable size. Their length naturally exceeds their thickness and it is rather seldom that the latter reaches more than a few feet.

Of more importance for quarry purposes, at least in this State, are the bosses and stocks of pegmatite that are characterized by a rounded or lenticular form as seen on the surface. Like bosses of ordinary granite, they seem to have made their own outlet toward the surface rather than to have followed some preexisting structural channel. They are more or less irregular in their boundaries, but in a general way approach an equidimensional form as seen in outcrop. They are well defined along the contact with the country rocks. They reach diameters of several hundred feet, as instanced by some of the occurrences in the eastern Adirondacks. They seem to be specially developed in the harder, more massive gneisses and in the granites themselves, whereas dikes occur both in these rocks and in the schists and sedimentary foundations, but are more characteristic perhaps of the latter.

Besides intrusive pegmatites, there are bodies occurring in the older granites and gneisses which seem to have originated in place by some process of differential crystallization while the magma was cooling; or in the case of gneisses they may have been found during a period of resoftening of the rock mass incident to metamorphism. They are of varied shape and size, often consisting of narrow bands that shade off on all sides to the parent rock or in large masses

that are bordered at times by fine-grained aplitic granite. Pegmatites of this nature have no economic importance as sources of feldspar or quartz, as the minerals are not sufficiently large or segregated to admit their easy separation.

The feldspar minerals. The general mineral composition of pegmatites has been given on pages 66 and 67 of this report. It should be noted, however, that feldspar, the principal economic product of the local pegmatites, is not a definite mineral species, but rather a mineral group, the members of which vary among themselves in chemical and physical properties, as well as in their industrial uses. The requirements for pottery spar, for which a fairly large and steady market exists, are such as to exclude all but a few varieties, and similarly there are certain restrictions generally upon the kinds that find use in other industries. It is therefore highly essential to ascertain the nature of the feldspar in pegmatite and its adaptability for different purposes before undertaking the development of a deposit.

The feldspar minerals are composed of silica and alumina with one or more of the bases — potash, soda and lime. It is usual to class them in two principal groups, the potash feldspars and the lime-soda feldspars, according to the nature of the bases present.

The potash feldspars correspond chemically to the formula, $KAlSi_3O_8$ or $K_2O.Al_2O_3.\ 6SiO_2$; accordingly when pure they should contain silica 64.7 per cent, alumina 18.4 per cent and potash 16.8 per cent. As a matter of fact, the potash seldom reaches the theoretical proportion, being partially replaced by soda which enters into the chemical structure or is contained in another kind of feldspar intergrown with the potash variety. The amount of soda present may range from 1 to 5 or 6 per cent. The potash feldspars include orthoclase and microcline, the former monoclinic and the latter triclinic in crystal form. Their distinction requires accurate measurements of the cleavage or interfacial angles, or a study of their optical properties under the miscroscope. Microcline is the more common variety in New York pegmatites. There is no difference in their value for pottery or other uses.

The lime-soda group of feldspars, or the plagioclases, consists of a continuous series that ranges from the pure soda variety, or albite, at the one end to the lime feldspar, anorthite, at the other. The composition of albite is represented by the formula $NaAlSi_3O_8$ or $Na_2O.Al_2O_3.6SiO_2$, corresponding to the following individual percentages: silica 68.7; alumina 19.5; soda 11.8. Anorthite has the composition $CaAl_2Si_2O_8$ or $CaO.Al_2O_3.2SiO_2$ and contains in per-

centages: silica 43.2; alumina 36.7; lime 20.1. The intermediate members are mixtures of the two in various proportions which can be expressed in general terms as $Ab_n An_m$. They include oligoclase, andesine, labradorite and bytownite, named in order from the soda to the lime end of the series. The feldspars with high percentages of soda are called the acid series on account of their relatively large proportion of silica in contrast with those high in lime, which are relatively low in silica. The identification of the different members requires accurate crystal measurements (all belong to the triclinic system but differ individually in form), or optical study, or chemical analysis, and the methods need not be explained here. The plagioclases commonly exhibit a striated appearance on certain faces which arise from minute parallel lines that mark the contact of lamellae in reversed or twinned position. This characteristic is not common to the potash feldspars.

The color of the feldspars exercises no influence upon their use, except as it may be due to the presence of iron stain or iron-bearing impurities. The potash feldspars commonly are light yellow, pink, red or gray in color. The color of plagioclase varies from pure white, most often seen in albite, to gray, brown or greenish, and less commonly reddish. The variations in natural color disappear when the feldspar is fused, the melt being usually white.

The use of feldspar in pottery and generally for glazing purposes is conditioned by the chemical composition which determines the temperature of fusion. The potash varieties, orthoclase and microcline, and the soda variety, albite, have the lowest melting temperatures. According to the more recent work of Day and Allen,[1] who carried out a very extensive series of experiments on the subject, these varieties do not melt at a definite point, but their fusion extends over a range of temperatures. In finely powdered microcline there was evidence of sintering at 1000° C., but the material was not actually fused until the temperature reached about 1300°. Albite fused at a somewhat lower point, but still above 1250° C. The lime-soda varieties melt at temperatures between 1340°, the fusing point of oligoclase, and 1532°, which is the melting point of anorthite.

Besides their lower fusing point, the feldspars that contain high percentages of alkalies possess a further important feature, namely, that on melting they yield a translucent glass. The varieties high

[1] Carnegie Institute Publications No. 31, Washington, 1905, p. 13-75; also Amer. Jour. Sci. 4th ser. v. 19. 1905, p. 93-142.

in lime, on the other hand, possess a strong tendency to crystallize and only consolidate in glassy form when quickly cooled. The crystallizing property becomes more marked with increase in the lime and is very strong in anorthite. This feature, of course, operates against the use of the more basic feldspars in pottery wares.

Uses of pegmatite. The products of the local pegmatite quarries include feldspar of different grades, quartz, mica and unsorted crushed pegmatite.

The uses of feldspar are various. The principal demand for high-grade potash spar is in the pottery industry, particularly in the manufacture of porcelain, semiporcelain and china tablewares, and porcelain sanitary wares and electrical supplies. The feldspar for such purposes should contain no more than a mere trace of iron, and very little muscovite or other mineral impurities except quartz, which is allowable up to a certain extent. In such wares it performs a double function, being employed to bind together the quartz and kaolin that constitute the body and also as a constituent of the glaze when this is required. The proportion of feldspar used in the body of vitrified wares ranges from 10 to 35 per cent and in glazes from 30 to 50 per cent. Bastin states [1] that the requirements in regard to allowable percentages of free quartz differ among individual potteries; a few manufacturers of high-grade wares demand a feldspar with less than 5 per cent of free quartz, but most potters perhaps use the "Standard" ground spar carrying 15 to 20 per cent of admixed quartz.

Manufacturers of enamel ware, glazed brick and terra cotta consume considerable quantities of feldspar. In enamel ware, the requirements are perhaps not so strict in regard to iron as in pottery manufacture, but the spar must be fairly free of quartz, as the latter tends to raise the melting point. Among enamel ware and terra cotta manufacturers, a preference is shown for albite over the potash varieties owing to its lower fusing point. Little of this mineral is found in the New York pegmatites, but it occurs in quantity in eastern Pennsylvania and in Maryland. Another use for the local feldspar is in the manufacture of opalescent glass. This requires a material of about the same quality as that for enamel ware, but may contain more quartz.

A large quantity of feldspar is employed as an abrasive, especially in the form of scouring soaps and powders. For that

[1] Feldspar Deposits of the United States, U. S. Geol. Sur. Bul. 420, 1910, p. 19.

purpose it is ground to an impalpable powder. It also finds use in the manufacture of abrasive wheels as a binder for the emery or carborundum with which the spar is mixed.

The quartz, which is an important ingredient of the local pegmatites, has value if obtainable in fairly pure condition. It is extensively produced at the Bedford quarries. The principal uses are in pottery and in the manufacture of abrasives and wood filler. The requirements for pottery are strict with regard to iron, but less so for other uses. The quartz from pegmatites may be regarded as a by-product, not of sufficient importance to warrant quarry operations for itself alone. Larger amounts of quartz come from quartz veins.

The unsorted pegmatite, when crushed, finds sale among makers of prepared roofing, in which it is employed as a surface coating with tar or some bituminous binder. The pegmatite is crushed to a pea size or a little coarser, the feldspar and mica yielding flat surfaces that are of advantage in securing firm adherence to the paper. The purity of the material is a subordinate factor and no effort is made usually to separate any of the ingredients. The fine material resulting from the crushing is sold for use in concrete and grout, and a small proportion in the coarser sizes finds a market as poultry grit. Crushed pegmatite has recently come into use in the preparation of artificial stone which is made to imitate granite and is cast in almost any form so as to require little or no dressing.

General considerations. The economic value of pegmatite occurrences depends upon a number of features, some of which have been mentioned already. The character of the feldspar will determine the adaptability of the product to different uses. In case the minerals are much intergrown, even if in fairly large individuals, the material can hardly be sold for the higher grades without so much expense in sorting and cobbing as to render the operations unprofitable. Such occurrences are adapted only for the production of unsorted pegmatite for roofing and concrete. To enable them to be worked profitably, they must be of large size and conveniently situated for shipment of the product to market.

Under the varying conditions presented by the occurrence and mineral nature of pegmatites, there is little that can be stated generally in regard to the value of undeveloped properties. As a rule, it may be said that a dike or lens less than 25 feet thick is not workable and one of that size can be worked profitably only under exceptional circumstances. Of course, much depends upon distance of haulage and the freight rates to market.

There is considerable uncertainty as to the quantity of available material in pegmatites, even when they have been well exposed at the surface. Unlike normal granites, they are very liable to sudden variations in the proportions and relations of the quartz and feldspar, such variations arising quite abruptly. This involves a considerable element of risk, particularly in the working of small bodies for some particular grade of feldspar. In the larger dikes and bosses, the desired quality may be obtained by carrying on work in several places and sorting the product carefully into grades. Thus at Bedford three grades of feldspar are produced from one body, besides a quartz by-product. With a small output, it is not practicable always to sort the product so carefully and there is consequently more waste.

THE LOCAL DISTRIBUTION OF PEGMATITES IN NEW YORK STATE

The pegmatites are limited in their occurrence to the two principal areas of early crystalline rocks represented by the Adirondacks and the southeastern Highlands. They occur in the vicinity of the larger granite intrusions, but the workable bodies are more often found on the periphery of such intrusions and within the older country gneisses and schists than in the midst of the granites themselves. They appear sometimes in the areas where ordinary granites do not outcrop, but in this case they may be offshoots of some buried mass that were able to reach the surface on account of their fluid condition.

The Adirondack region is well supplied with pegmatites, but they are by no means equally distributed. The great anorthosite mass that spreads over the eastern central part, mainly within Essex county, is naturally devoid of occurrences, as it is of later intrusives generally, except those of basic character. In the fringe of gneisses to the east of that mass there are granite intrusions and pegmatites, some of the latter of large size, as those near Crown Point and Ticonderoga. In the northern Adirondacks, which is largely occupied by a belt of very old gneisses, few intrusions of younger granite are encountered. So far, only one large pegmatite body has been reported in that section. The southern Adirondacks have a number of occurrences and it may be expected that others will be found here as the region is more carefully explored, but they are likely to be in the more inaccessible parts. The western Adirondacks, particularly the section included in St Lawrence, Jefferson and northern Lewis counties, is known to include numer-

ous bathyliths and bosses of granite, covering a larger portion of the surface than in any other part; the granites are mainly coarse varieties, rich in quartz and containing segregated masses of pegmatite. The conditions thus appear very favorable for the occurrence of extensive bodies in that section, but the remote and inaccessible nature of much of the area has rather discouraged exploration.

In the Highlands region and southward into Westchester county pegmatites are quite abundant but only rarely reach workable proportions. They occur mainly in the Precambric gneisses, but may be of much later age than the latter as the granite invasions continued down into Siluric time. The principal bodies that have been worked are near Bedford, Westchester county. In the central Highlands there is much pegmatite and coarse granite in evidence, usually pinkish or grayish in color, but there are no developed quarries. The pegmatites occur in considerable bodies in the vicinity of some of the magnetite deposits.

The present description of the pegmatite localities includes mention of all of present or prospective importance that have come to the writer's attention during rather extended travels in the field. A few have been mentioned in previous reports of the State Museum, and many of the better known occurrences are given detailed treatment in Bastin's monographic bulletin, "Economic Geology of the Feldspar Deposits of the United States," already cited.

CROWN POINT, ESSEX COUNTY

Quarry of the Crown Point Spar Company

The pegmatite quarry worked by the Crown Point Spar Company is on Breed's hill, south of Crown Point, about 1¼ miles west from Lake Champlain. The pegmatite outcrops on one of the summit knobs, 500 feet or more above the lake level. It was discovered some years ago by Charles Wait of Crown Point, the present manager in charge of the quarry. It is apparently a large, somewhat irregular lens or stock, with a longer diameter running northeast-southwest parallel to the general tend of the surrounding gneisses. The full size is not revealed, but it measures several hundred feet at least in that direction. Toward the border it becomes finer grained. The country gneiss is a dark, banded variety, much of it an amphibolite, and is intruded by aplite and pegmatite. Small masses of the latter may be observed, which approximate the shape of the larger body; they are irregularly bounded and contain patches of the country gneiss that have been torn away from the walls.

The pegmatite consists of two varieties of feldspar, one a light pink and the other greenish; also quartz and biotite, with occasional small crystals of titanite, magnetite, zircon, tourmaline, pyrite and

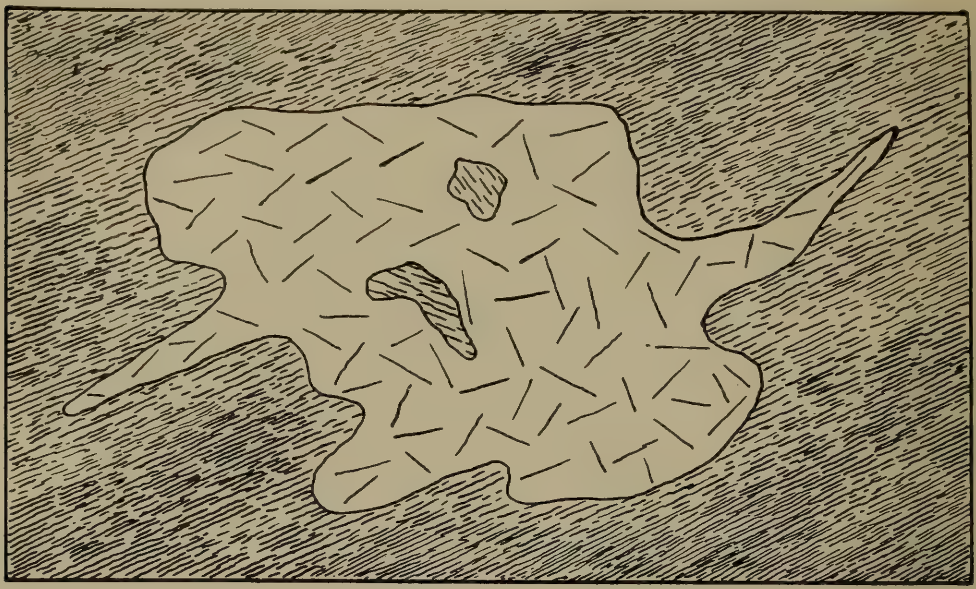


Fig. 13 Intrusion of pegmatite in gneiss, near quarry of Crown Point Spar Co., showing the bosslike shape of the pegmatite masses in this section

chalcopyrite. Bastin reports also the presence of allanite. Chlorite occurs as a secondary development along planes of slipping incident to compression. The quartz and feldspar are rather intimately intermixed, but single individuals of either occur up to 6 or 8 inches in diameter. An examination of the feldspars under the microscope show that the pink variety is microcline and the greenish a plagioclase in optical properties close to oligoclase. Most of the iron is present in biotite which is rather abundant though unequally distributed.

The principal product of the quarry is roofing material but other grades are sold for concrete, poultry grit and enamel wares. The spar for the latter purpose is obtained from sorted material that is free of iron minerals, with microcline as the main ingredient. The biotite is screened out and finds application in paint.

The pegmatite as quarried is conveyed by an overhead tram to the mill which is situated at the base of the hill close to the lake and railroad. It is there passed through a preliminary crusher of the Blake type, then dried and further reduced by rolls and sized on screens. The pottery grade after crushing and drying goes to a chaser for final reduction. The crushed pegmatite is graded into six sizes of which the coarsest (no. 2) will pass a 2½ mesh screen

and is caught on a 3½ mesh screen, and the finest (no. 6), which is like very fine sand.

Roe's quarry

Roe's quarry, locally known as Roe's spar-bed, is about 8 miles northwest of Crown Point in the vicinity of Towner pond, near the Moriah town line. The locality more precisely is three-fourths of a mile directly south of Towner pond and one-fourth of a mile east of the highway leading past the pond. It is in a very rugged section, quite close to the main anorthosite intrusion, lying well up on a ridge at an elevation of between 1100 and 1200 feet, according to the contour map.

The property was last worked fifteen years or more ago as a source of pottery spar. The output, which must have been considerable in view of the size of the quarry working, was hauled to Crown Point for shipment at a cost of from $1.25 to $1.50 a ton. The property now belongs to H. W. Willcox of Crown Point.

The opening in its present condition is 75 feet wide running northeasterly into the ridge and has a face 50 feet high. Apparently the body has the shape of an elongated lens, from 75 to 100 feet wide and of uncertain length. The bounds are not clearly revealed by outcrops and there is some doubt as to the extent of the pegmatite outside of the part worked. The longer axis appears to run about N. 50° E. as indicated by a series of test pits below the main opening. Above or northeast of the quarry the country rock, a grayish hornblende gneiss, outcrops within a short distance of the line of strike, so that apparently there is not much more to be quarried in that direction. A large supply exists, however, in the floor of the quarry which could be conveniently worked, and probably also good material would be found to the southwest. The existence of feldspar on the adjoining property to the south of the Roe quarry was reported to the writer, but the locality was not visited.

The feldspar occurs in very large crystals and aggregates, well segregated. Individuals with a cross-section of 3 feet are not uncommon. Some show fine crystal boundaries as they project from the walls of the quarry. There are two varieties of feldspar present, pink and grayish white, the former showing the properties of microcline and the latter of oligoclase. They appear to be in about equal amounts. Quartz occurs in subordinate quantity and is unequally distributed, being practically absent over considerable areas. It is pink or milky in color. Graphic intergrowths with feldspar are in

evidence, but the proportion is small. Of iron-bearing silicates, biotite and black tourmaline are fairly common, but for the most part are segregated in bunches, so that their presence would not entail any great waste in sorting for pottery materials. Altogether the pegmatite is exceptionally adapted for the production of feldspar.

The face of the quarry is cut by four trap dikes, from 1 inch to 2 feet thick, which are quite closely spaced and probably coalesce below.

The main difficulty in the way of successful operation of the quarry seems to be its remoteness. The nearest outlet to the railroad is by way of Crown Point over a rather rough country, but with the grade favoring the load.

Penfield Pond occurrence

A body of pegmatite of large size occurs on the road leading west from near the south end of Penfield pond. It was noted by the writer several years ago, but was not examined with regard to the quality of the materials.

In the report by Dr Ida H. Ogilvie on the Paradox Lake quadrangle,[1] it is stated that pegmatites are abundant in the vicinity of Crane pond.

TICONDEROGA, ESSEX COUNTY

Quarry of Barrett Manufacturing Company

The Barrett Manufacturing Company has operated a quarry near Ticonderoga for several years past, using the crushed pegmatite in the preparation of sheet roofing. The quarry is situated about 2 miles northwest of the village of Ticonderoga at the eastern base of the ridge of Precambric rocks. The occurrence is very similar to that described near Crown Point, consisting of a large lens of pegmatite included within gneisses of the Grenville series with the larger axis parallel to the strike of the latter, which is about N.55°E.

The pegmatite is made up of quartz and feldspar which are not very well segregated and do not attain large size, the individual crystals being seldom more than 4 or 5 inches across. The feldspar consists of two varieties, the more abundant being a white or grayish microcline. The second variety is a light green oligoclase. Intergrowth of the quartz and feldspar is the usual condition. The

[1] N. Y. State Museum Bul. 96, 1905, p. 488.

principal iron mineral is biotite, which forms rather large crystals but is very unequally distributed. There is some secondary chlorite. Black tourmaline, garnet and iron sulphides occur sparingly. The character of the pegmatite thus agrees very closely with the Crown Point occurrence and is no doubt connected with the same series of granite intrusions.

The product of the quarry is reduced in a mill nearby, equipped with jaw crusher and rolls and screens for sizing. The material too fine for roofing is sold for concrete and grout. No pottery grades are obtained. The output is hauled by wagons to Ticonderoga for shipment.

Mount Defiance quarry

An abandoned quarry is found on the north end of Mount Defiance between Montcalm Landing and Ticonderoga. It was worked several years ago by the Ticonderoga Feldspar Co. The rock strictly is not a granite pegmatite, but a coarse phase of the country gneiss which belongs to the syenitic class. It contains hornblende and pyroxene with some quartz and a perthitic feldspar.

FORT ANN, WASHINGTON COUNTY

Ashley quarry

An exposure of pegmatite near Fort Ann has been worked at different times for feldspar and quartz. It is one of the localities from which quartz was obtained for grinding at the mill that was operated at Fort Ann about twenty-five or thirty years ago. More recently it has been a source of feldspar and has been worked intermittently according to the prevailing market demand, the last time by Dominick Ashley of Glens Falls.

The outcrop lies about 2½ miles northwest from Fort Ann at the base of the gneiss ridge, of which the higher part is known as Putnam mountain. It is on or adjoins the farm of Ira D. Gilmore. It consists of a rather irregular area, suggesting somewhat a lens, with a longer axis nearly at right angles to the trend of the ridge or to the northwest. An open pit about 125 feet long and from 30 to 40 feet deep has been made but is now largely filled with water. The lens is broadest near the southeastern end where it measures fully 75 feet across. To the northeast it gradually diminishes and wedges out in the gneiss 50 feet beyond the end of the pit. The gneiss wall rock is a laminated biotite variety that may be classed with the Grenville series.

The pegmatite contains much graphic intergrowth of feldspar and quartz, although the two minerals also occur separately to a considerable extent.

The quartz masses reach a diameter of 2 or 3 feet and the feldspar a similar size. Most of the feldspar has a grayish color and belongs to the microcline variety. There is also a little pinkish feldspar which may be orthoclase. Tourmaline and the iron-bearing silicates generally have a very limited representation, though the material is much stained by iron oxides, the result probably of oxidation of sulphides.

The pegmatite shows alteration in places, with the formation of kaolin and sericite, and takes on a greenish coloration which seems to be traceable to secondary serpentine. The presence of this mineral is not connected apparently with any magnesium compound of the pegmatite, but is referable to the alteration of the feldspar and to the introduction of magnesium compounds from outside sources. Apparently the pegmatite has been a channel for ground water circulations.

CHESTERTOWN, WARREN COUNTY

Wilson Brown quarry

The name of this quarry is given on the authority of residents of Chestertown, who stated to the writer that the property was last worked about fifteen years ago. The purpose of the operations originally was the production of mica. The locality is 3 miles south of Chestertown on the north side of a high ridge 1½ miles east of the Warrensburg road. Two workings may be seen, the principal one being to the south and higher up on the ridge. This consists of an open cut about 50 feet long and 15 feet wide on a dike or elongated lens of pegmatite that strikes northeast. The limits of the body are uncertain, except on the east side of the pit where the country rock appears within a few feet of the wall. The more northerly pit is probably a separate body, unless the pegmatite has a much larger extent than seems to be indicated. It is a narrow opening of undetermined depth.

EDINBURG, SARATOGA COUNTY

Gordon quarry

In 1906 the Claspka Mining Company of Trenton, N. J., opened a quarry in the town of Edinburg, Saratoga county, which the company worked for two or three years for pottery spar. The locality

of the quarry is 2 miles north of Batchellerville, on the road to Day, on the farm of Adelbert Gordon. The nearest railroad point is Northville, the northern terminus of a branch that connects at Fonda with the New York Central lines, necessitating a wagon haulage of 8 or 9 miles over a somewhat rough country.

There are two openings on the property, situated about one-fourth of a mile east of the highway at the base of the ridge which forms the steep eastern slope of the Sacandaga river valley. The lower or westerly pit has been worked to a depth of about 50 feet. Its horizontal dimensions are about 75 feet by 50 feet, indicating the usual stock form in which most of the larger bodies of pegmatite occur, but the whole area of the pegmatite is not shown. The minerals are in coarse crystals and fairly well segregated, though there is considerable graphic intergrowth of quartz and feldspar. The former is found also in pure masses of white and pink color up to a foot in diameter. The feldspar is mostly grayish microcline, but is intergrown to some extent with a white variety which microscopically corresponds to albite. The largest individuals observed were fully 3 feet in length. Much waste in quarrying was incurred from the presence of abundant mica and owing to the existence of an included lens of the wall rock. A large quantity of quartz, mica and mixed material was left at the quarry after the feldspar had been sorted for shipment.

A feature of this quarry is the fine crystals of muscovite and beryl which occasionally attain very unusual dimensions. The muscovite forms books and columnar crystals that measure a foot or more in diameter and from an inch or so to 10 inches thick. The mica, however, is not generally suitable for cutting as it shows rulings and contains inclusions of iron oxides. The beryls are the largest that have been found in the State; one crystal, now in the State Museum, has a length of 27 inches and a diameter of 10 inches. The larger ones are opaque and greenish in color, but some small crystals have been found that were fairly clear aquamarines. They show the hexagonal prism faces but are not terminated.

A second pit lies to the east of the one described and is of smaller size. The pegmatite has the same general character as noted but shows some garnet.

There appears to be a good body of pegmatite at this place, though the contact against the country gneisses is not so well disclosed as to permit an estimate of the exact size. The gneiss is a biotite variety with augen of feldspar and shows a foliation that strikes about N. 50° E. and dips 30° southeast. Apparently the

pegmatite does not conform to the structure of the gneiss, but breaks across the foliation, which it would naturally do if it were in the nature of a stock rather than a dike.

The occurrence still possesses value for the production of pottery spar. The main drawback at present is the expense of haulage.

CORINTH, SARATOGA COUNTY

Quarry of American Feldspar & Milling Co.

This quarry is a practically undeveloped property from which only trial shipments have thus far been made. The Corinth Feldspar Co. did some work on it in 1908, but relinquished control to the company named, who are its present owners. The property is about 3 miles southwest from the Corinth railroad station and 700 feet above it.

The pegmatite has a width of about 60 feet and is exposed over a vertical distance of 130 feet. It has not been sufficiently developed to indicate the shape of the body, but it is perhaps an elongated lens or dike intruded parallel to the foliation of the surrounding gneiss which trends a little west of north. There is more or less of the rock in evidence over a distance of 2000 feet. The pegmatite consists mainly of an intergrowth of quartz and feldspar, with only a small part of either mineral in free crystals serviceable for pottery uses. The feldspar is an untwinned variety that appears to be orthoclase, a rather rare form for Adirondack pegmatites. There is considerable biotite which is so equally distributed as to render its separation a matter of difficulty.

MAYFIELD, FULTON COUNTY

Tyrell quarry

This occurrence of pegmatite was worked a few years since by the Claspka Mining Co. along with the quarry near Batchellerville. It is situated in the town of Mayfield, 3 miles west of Cranberry creek, on the farm of Richard Tyrell. The outcrop lies well up on the gneiss ridge, 800 or 900 feet above the railroad which terminates at Northville, 5 miles above Cranberry creek.

The main body of pegmatite is opened by a pit 50 or 60 feet across and heading into a ridge in a northeasterly direction. The quarry face as left by the former operations is over 50 feet high. The materials are coarsely crystallized, the quartz and feldspar reaching a maximum diameter of 3 or 4 feet. The feldspar includes pinkish microcline and a white striated albite. The latter is

usually predominant, while the microcline is so much intergrown with biotite as to cause much loss in sorting. There is also a little of greenish gray oligoclase. On the east side of the quarry a trap dike intervenes between the pegmatite and the country gneiss. Biotite and tourmaline are the iron-bearing impurities. The latter is in small amount, associated more especially with the quartz. The biotite is rather abundant and in large crystals.

It would appear that the spar from this quarry might prove very serviceable for enamel ware and for glazing brick and terra cotta, for which purposes albite is considered preferable to the potash varieties on account of its lower fusing point.

There are several places in the vicinity of the quarry where pegmatite outcrops. One showing is just northeast, a ledge 30 or 40 feet long, with reddish feldspar and some biotite. An 8-foot dike occurs just west of Mr Tyrell's house and contains reddish feldspar and pink quartz, with little mica or other dark silicates. The locality may be considered one of the more promising places for exploration for feldspar in this section.

DE KALB, ST LAWRENCE COUNTY

Rowland property

The existence of a ledge of coarse pegmatite in the town of Bigelow, St Lawrence county, was brought to the writer's attention some time ago by J. H. McLear of Gouverneur. The occurrence is 3 miles northeast of Bigelow, between that place and East De Kalb. It is exposed in natural outcrops rising in low ridges above the general surface. One of the ridges is on the Rowland farm and another occurs on an adjoining property. They are conspicuous objects on account of the white color which is contributed both by the feldspar and the quartz.

The principal ledge is about 75 feet long and 40 feet wide, but these measurements are based on the actual exposure and the body is undoubtedly considerably larger, as there is no evidence of any walls where the pegmatite disappears below the surface. A second ledge is found 300 feet southwest of the first, practically in the direction of the longer axis of the first; and the pegmatite is said to be exposed in other places which, however, were not seen by the writer. There is little doubt that the occurrence represents a large mass of the pegmatite, but whether in a single body or in two or more bodies is not apparent.

The exposures reveal fresh, unaltered rock from the very surface. There is no iron stain and practically no iron silicates are in evidence, though an occasional grain of pyrite occurs in the quartz. The latter is milky white and forms unmixed masses, but mainly occurs intergrown with the feldspar. There is only one kind of this mineral, so far as could be established from a hasty examination; the feldspar is white perthitic microcline that might readily be mistaken for albite except for the lack of striations. The microcline on close examination shows a very fine intergrowth with another feldspar, also white, that has the optical properties of albite. There is perhaps one-fourth as much albite as microcline. The included bands of albite are approximately normal to both cleavages. The feldspar occurs in crystals from 6 inches to 3 feet long. It is probable that a fair proportion of first-grade pottery spar could be secured, but the larger quantity would have to be graded, however, on account of the quartz. This opinion is based, of course, solely upon the surface showing and there is need of careful prospecting before any attempt is made to extract material for shipment.

The ledges are only slightly above the ground level and a quarry would soon develop into a subsurface working that would require draining. The conditions otherwise seem favorable for economical work. The railroad passes within one-fourth of a mile of the property.

FOWLER, ST LAWRENCE COUNTY

Denesia property

A dike of pegmatite with well-crystallized feldspar occurs on the farm of C. W. Denesia about 2 miles south of Fullerville, in the town of Fowler. There is a single exposure which seems to be of a dike, but it is too limited in area to permit much certainty regarding the nature and size of the body. The outcrop is only 8 feet wide. With the very small area of rock exposed there is a probability that the occurrence may be of greater importance than is at present indicated. The feldspar occurs in splendidly developed crystals from 2 to 3 feet long, inclosed in a groundmass of intergrown quartz and feldspar with which tourmaline and biotite are associated. It consists of a deep red microcline and also of a lighter pinkish variety that is an intergrowth of microcline and albite.

FINE, ST LAWRENCE COUNTY

Scott property

There are several occurrences of pegmatite on the Fred Scott farm, 4 miles north of Oswegatchie, in the town of Fine, St Lawrence county. They are of interest for the associated minerals as well as for possible supply of quartz and feldspar. The feldspars occur in pink, white and greenish colors, evidently including both potash and lime-soda varieties. They are seldom found in segregated masses or crystals, but are mostly intergrown with quartz and some of the other minerals. Among the mineral species represented are fluorite, hornblende, pyroxene, pyrite, chalcopyrite and titanite, some being well crystallized. The association suggests a granite contact with limestone, and in fact the latter rock is found in scattered patches in the vicinity.

BEDFORD, WESTCHESTER COUNTY

Quarry of P. H. Kinkel & Sons

The body of pegmatite situated in the hill southeast of Bedford village has for a number of years furnished a very large part of the feldspar and quartz production of the State. Besides the four openings included in the Kinkel quarry, the Bedford Feldspar Co. has recently developed a new quarry on the same body. The occurrence is notable not only for its size, but for its good examples of crystallized and rare minerals and for the varied conditions presented by the mineral association in different parts of the exposure.

The several openings in the Kinkel quarry lie along the eastern and northern sides of the hill, the original pit being on the east side near the present mill. At this point the pegmatite shows more or less disintegration from surface weathering, so that operations have not been as actively carried on here as in the other pits higher up on the hill slope. These include two very large pits of which the more southerly one is about 300 feet long, 150 feet wide and has a face up to 50 feet high. The central one is not quite so long and the more northerly one is about 100 feet long, 50 feet wide and 35 feet in greatest depth. Between the different pits and even in parts of the same working a marked variation may be observed in the arrangement and character of the pegmatite minerals. Though feldspar is the main component throughout most of the

exposure, it gives way in places to a nearly pure quartz aggregate. Quartz is particularly abundant in the central part of the southern pit where it occurs in a large zone which here and there incloses a crystal or mass of pink feldspar. On either side of the quartz zone for some distance occurs a mixed phase of quartz and albite in pegmatitic intergrowth, with occasional segregated individuals or masses of the pink feldspar, which is microcline. The pink feldspar occurs by itself also in considerable bodies. The white albite is mainly developed as a graphic intergrowth with the quartz. Between the different phases exhibited by the feldspar, quartz and intergrowths of the two, it is possible to have every gradation. The conditions seem to indicate more or less segregation of the constituents during the process of intrusion, facilitated no doubt by the extreme mobility of the magma. Lack of uniformity is rather characteristic of the larger pegmatitic bodies, and similar features may be seen in other occurrences though they are not so well shown as in these quarries.

The feldspar from the different workings is graded according to character and content of quartz. The microcline, which occurs mainly in quite pure crystals and aggregates, constitutes the first grade, suitable for pottery purposes. The albite that is fairly free of quartz, but not entirely so, is sold as enamel material. The pegmatitic intergrowth of albite and quartz, with more or less of the pink variety as well, is used in glass manufacture, scouring soaps, etc. The first grade has generally been sold in crude condition, as the mill until recently was not equipped for grinding pottery material. The others were ground at the quarries. Besides the feldspar, there are obtained large quantities of quartz, which is shipped crude to the Bridgeport Wood Finishing Co. for wood filler and silica paint material.

The more common associated minerals included mica, tourmaline, and beryl; occasional ingredients are garnet, ilmenite and some of the uranium minerals. The mica is principally muscovite and occurs as included crystals in the feldspar or in the finer pegmatitic intergrowths along with the feldspars and quartz. The crystals seldom exceed 5 or 6 inches in diameter. They are much fractured and scarcely suitable for cutting of sheet mica. The biotite is in larger crystals but not so plentiful as to give much trouble in its removal. The tourmaline is the common black variety; it is mostly associated with the quartz as well-shaped prismatic crystals and as a thin crystalline coating on the surfaces. The beryl forms flat and prismatic crystals, occasionally well-

Plate 24

Pegmatite quarry, Bedford. One of several openings on the property of P. H. Kinkel & Sons

bounded, reaching diameters of 6 or 8 inches. It is usually opaque, yellowish green in color. The rare compounds, autunite, cyrtolite and uraconite all of which contain uranium are listed by Luquer [1] as occurring at Bedford. The first-named occurs rather frequently as a bright greenish-yellow deposit on the feldspar and mica. The writer has recently observed the presence of columbite in crystalline masses of considerable size.

In connection with the quarry, P. H. Kinkel & Sons operate a mill for grinding the spar. The equipment consists of a breaker, chasers and screens with a pebble mill for the fine grinding of pottery spar. This is a recent addition, as formerly only the second and third grades were ground, for which purpose the final reduction was accomplished in a ball mill.

The output of the quarries is shipped from Bedford station on the Harlem branch of the New York Central, necessitating a haulage of 5 miles.

Quarry of Bedford Feldspar Co.

This new opening lies at the base of the hill and a few hundred feet north of the Kinkel quarry. The continuation of the pegmatite in that direction was concealed by a cover of soil and earth and was first explored by test holes before development work was begun.

The existence of the pegmatite rather indicates that the mass is not a dike in the usual sense of the word, but another of the rounded bodies or stocks that constitute the usual mode of occurrence of the larger masses. If a dike, it does not conform in direction with the general structure of the gneisses, but has a northerly strike. The great width of the body exposed in the Kinkel quarry is exceptional for a dike. It is possible that the present quarry is on a separate intrusion, but this scarcely seems likely in view of the character of the material.

The working is all below the ground level and when seen in the spring of 1913 was about 30 feet deep with a diameter of 75 feet. The pegmatite is the same coarse aggregate as found farther south but carries a larger proportion of feldspar than the average in the Kinkel quarry. The material is somewhat stained and decomposed, but fresher material should be found in depth.

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[1] "The Minerals of the Pegmatite Veins at Bedford, N. Y." The American Geologist, v. 18, 1896, p. 259–60. Also American Geologist, v. 38, 1904.

The company has erected a mill on the property in which it grinds all the spar, shipping the ground material to tile, enamel ware and glass manufacturers. The capacity is 35 or 40 tons a day. The equipment for final grinding consists of ball mills. Auto trucks are used to transport the material to Bedford station, the shipments being made in bags.

Bullock quarry

The firm of P. H. Kinkel & Sons opened a new quarry in 1912 on the Bullock property about 2 miles south of their main quarries. The property is west of the Hobby quarry. The occurrence is very similar to the latter in the quality of the product but is not apparently connected with it. It consists of a dike 30 feet wide which strikes northeast and dips 80° to the northwest. The wall rock exposed on both sides is a mica schist, garnetiferous near the contact with the pegmatite, and resembling the Manhattan schist in its general appearance.

The pegmatite shows a high degree of mineral segregation with very little of pegmatitic intergrowth. It is mostly feldspar of a cream or buff color, which on examination is seen to be an intergrowth of microcline and albite with the former predominant in the proportion of 2 or 3 to 1. It occasionally shows good crystal boundaries. The individuals measure as large as 2 feet or so in length, but are mostly smaller. The quartz has a smoky color and near the contact shows crystals of garnet. Tourmaline and yellowish mica are in subordinate quantity. The feldspar is readily separated with little waste, so as to be shipped as no. 1 grade.

The opening is on the side of a hill and presents a face about 30 feet high. It can be deepened considerably before it is necessary to provide artificial drainage. The product has been shipped crude for abrasive uses, but is an excellent material for pottery or glazing. It is noteworthy that the same varieties of feldspar are represented as in the Bedford quarries, but occur in pegmatite intergrowths and not segregated.

Hobby quarry

The Hobby quarry lies a little east of the Bullock beside the Mianus river. It was worked for a time by Otto Buresch and later by P. H. Kinkel & Sons, but for the last few years has been idle. It appears to be based on a large body, though the contacts with the country rocks are not shown. The working is perhaps 150 feet long by 100 feet wide.

Plate 25

Quarry and mill of the Bedford Feldspar Company. The quarry pit is in foreground at extreme right

The pegmatite has the same character as that described for the Bullock property, but is somewhat coarser. Aggregates of feldspar 10 feet in diameter are found, as well as equally large masses of white and rose quartz. The conditions are thus excellent for the production of high-grade materials. The feldspar is cream colored and is made up of microcline with small albite bands. There is a small quantity of muscovite in scales and plates associated with it. Black tourmaline also occurs in limited amount. The property undoubtedly will be worked when the market affords sufficient inducement. The long haulage of 7 or 8 miles is the main drawback to operations at present.

Section 6

THE NEW YORK MARBLE QUARRIES

GENERAL CHARACTERS OF MARBLES

Marble, like granite, is a term used by quarrymen for a variety of rock materials. Any limestone that takes a polish or possesses ornamental qualities is a marble in the trade sense, and some of the softer silicate rocks are likewise thus designated, notably those having a serpentine base. More properly the name belongs to the crystalline or metamorphic class of limestones as distinguished from the compact to finely granular kinds occurring in the regularly bedded formations.

The quality of crystallinity is not always lacking in ordinary limestones, for some show aggregates of plainly visible calcite grains with the characteristic calcite cleavage surfaces; for example, the Chazy limestones of the Champlain valley. But their texture is never so completely crystalline as in the types that have undergone a metamorphic rearrangement of their constituents while subjected to compression in the depths of the earth. Such partially crystalline limestones often polish well, but lack the glint and translucency of true marbles. In this case, the presence of coarse crystalline calcite probably results from the working over of the finely divided particles by ground waters.

The microscopic appearance of a true marble is quite distinct from that of any carbonate rock which has not undergone pressure metamorphism. In the first place, the particles of calcite (or dolomite) are more uniform as to size and shape, whereas the texture of nonmetamorphic limestones is apt to be very variable and the size of grain shows a wide range. When crystallization takes place under conditions of cubic compression which characterizes the metamorphic process at considerable depths, the individual particles have not opportunity to develop the characteristic outward forms that calcite ordinarily assumes, but must accommodate themselves to the narrow space restrictions resulting from the simultaneous crystallization of the whole mass. As a consequence, they exhibit a more or less even, granular habit with curved or irregular boundaries which are closely matched together. A second characteristic of the metamorphic limestones as seen in thin section is the striations, broader than the lines of cleavage, that cut across the grains. These mark the junctions of crystals in so-called twinned

positions; they are not found in calcite particles of ordinary bedded limestones.

In the metamorphic change from limestone to marble, the bedded structure as shown by the separation into parallel layers is usually obliterated. Marble normally has a massive appearance and is so coarsely jointed that blocks of almost any size may be quarried. It also lacks any definite cleavage, a feature that is of great advantage in the working of the stone.

Serpentine marbles include several types. Serpentine is a hydrated silicate of magnesia and iron, which has the same hardness as calcite. The associations of the two minerals, therefore, does not affect the capacity of a marble to take a polish. Verde antique is a serpentine irregularly veined with calcite. Another type consists of crystalline limestone in which occur scattered grains of serpentine of the size of peas, giving a white base speckled with green. Serpentine also occurs unmixed with carbonates and then exhibits oftentimes an attractive appearance by reason of variations in color which ranges from light translucent green to dark green and even black. Its origin is traceable usually to the decomposition of such minerals as pyroxene, amphibole and olivine. The larger bodies of serpentine are formed by the weathering of igneous rocks in which those minerals predominate.

MINERAL CONSTITUENTS OF MARBLE

Marbles may have either calcite ($CaCO_3$) or dolomite ($CaMgC_2O_6$) as the principal ingredient, or they may contain a mixture of the two in any proportions. A pure calcite marble would have the same composition naturally as the mineral itself, which consists of lime (CaO) 56 per cent and carbon dioxide (CO_2) 44 per cent. Theoretically, a dolomite marble should contain lime (CaO) 30.4 per cent, magnesia (MgO) 21.7 per cent and carbon dioxide (CO_2) 47.8 per cent. These percentages, however, are never found in commercial marbles, owing to the invariable presence of other ingredients. The highest grades of white statuary marble, as represented by the best Italian and Greek examples, carry, however, over 99 per cent calcium carbonate, and there are American marbles nearly, if not quite, as pure.

Between calcite limestones and the dolomites, every degree of gradation is to be found, since the two minerals intergrow with each other in any ratio; such mixed phases are commonly designated as magnesian marbles or limestones, as the case may be. There is

no discernible difference in the outward appearance of a calcite limestone and a dolomite, and their distinction requires the use of chemical or microscopic methods. The slight difference in hardness is not a reliable criterion. The two minerals have similar crystal properties, including perfect cleavage which yields surfaces of rhombic outline. It is this cleavage that produces the bright reflections of light and gives life to the crystalline marbles.

The impurities in marbles take the form usually of scattered grains or crystals of the same order of magnitude as the calcite particles. In bedded limestones, on the other hand, they are distributed more or less evenly through the mass and consist of finely divided clayey and siliceous materials — the mechanical sediment formed during the deposition of the dissolved carbonates. The clay and silica form new combinations in the process of metamorphism, the carbonates supplying the lime and magnesia that may be required for the secondary minerals. Among the common foreign ingredients are muscovite, diopside and tremolite, but a great number of other silicates may occur. Any fine carbon is converted into scaly graphite. Some of the silica may remain as quartz. The iron minerals include hematite, magnetite and pyrite. The last-named is most harmful if present in any amount, since it decomposes readily in the atmosphere, producing a rusty stain which will spread over large areas.

TEXTURE

The texture of marbles varies greatly between examples from different localities. Some characteristic textures of New York marbles are illustrated in figures 15 and 17. The grain may be medium or fine, or may be uneven through the occurrence of different sizes of particles. The shape and arrangement of the particles also are quite variable and upon these features depend to a great extent the strength and weathering qualities of the stone. The Gouverneur monumental marble, composed predominately of calcite, has a very compact texture, with grains of uneven size and of angular to subrounded form. The particles frequently show dentate outlines by which they are firmly interlocked; the general appearance in fact is suggestive of the welded and dovetailed arrangement exhibited by some granites. The dolomite marbles of southeastern New York range from exceedingly coarse to very fine-grained varieties, but usually the grain in any one sample is fairly even. Some have a compact and firmly knit texture and then are

strong durable stones; others are made up of rounded, smooth particles which simply adhere without interlockment. The latter kind are less durable.

WEATHERING QUALITIES

Marbles are much more subject to solvent action when exposed to the weather than the silicate rocks, and the effects of solution upon most marbles exceed those of mechanical agencies in promoting decay. Pure water, however, has little solvent power upon either calcite or dolomite; the action of atmospheric moisture depends upon the small amounts of acid constituents which are absorbed from the air. All rain water contains carbonic acid, and in cities where the consumption of soft coal is large it carries also more or less sulphuric acid formed by the combustion of the sulphide impurities in the coal. It may be expected, therefore, that the same marble will weather more rapidly in a humid climate than in a dry one. Fog and mist have an accentuated effect as they absorb relatively large proportions of the acids and enable the moisture to penetrate deeply into the stone.

A dolomite marble, under the same conditions and of equal quality in regard to textural characters, should prove more resistent to ordinary weathering agencies than a calcite marble. The fact is, however, that many dolomites succumb rather rapidly on exposure to the weather, as is shown in some examples that have been employed for building purposes in the East. Decay in these cases may be attributed mainly to the possession of an open weakly bonded texture which facilitates the penetration of moisture and attack by frost.

The dolomite marbles of southeastern New York include examples of exceptionally good building materials which have withstood well the severe tests of our climate and also others that have decayed rather rapidly under the same conditions. Smock[1] has given particulars of the relative durability of different marbles used in New York City, and states that some of the dolomites have a durability compared with that of the best sandstones. The old United States assay office in Wall street was built in 1823 of Tuckahoe marble; though yellow from age, the surface remained smooth and the edges sharp, whereas the Italian marbles used in the caps of the columns were much weathered. An example of rapid decay is found in the State Hall in Albany which was built between 1835

[1] Building Stone in New York. N. Y. State Museum Bul. 10, 1890, p. 292–94.

and 1842 of dolomitic marble from Ossining. The outer walls are roughened by pitting and scaling, and the cornices, lintels and columns are so much disintegrated by solution and frost as to present a very bad appearance. The stone is coarse and mealy in texture, ill suited for building purposes.

The composition of a marble, so far as relates to the relative percentages of calcium and magnesium, probably has a very subordinate influence upon weathering qualities. Much more important is the texture, and this is a feature that varies greatly with each particular quarry. The size of grain is not necessarily an indication one way or the other; though the coarse stones may possess larger and more continuous pores, their grains present relatively smaller surfaces to the attack of solvents than do the fine-grained sorts. The main elements determining the weathering qualities are the degree of compactness and the coherence between the grains. These can be ascertained by physical tests for porosity and tensile strength, and by study of thin sections under the microscope.

The presence of silicates in large crystals is detrimental to marble used for outside work, since there is not the same coherence between the crystals of silicates and those of the carbonates as between the carbonates alone, and consequently moisture gains access along their boundaries. Sulphides are still more obnoxious, not only producing iron stains, but also causing decomposition and pitting of the surface through the action of the sulphuric acid which is always formed by their oxidation.

Dale[1] has made some interesting observations on the effects of the New England climate upon marble monuments and tombstones and states that white marbles after exposure for 75 or 100 years have so far weathered as to indicate the complete effacement of the lettering within 300 years of the date of cutting.

Smock[2] gives as a quotation, the following notes in regard to the durability of the Gouverneur marble:

The Gouverneur marble was employed at least fifty years ago for gravestones, and in the Riverside Cemetery, at Gouverneur, these old gravestones, bearing the dates from 1812 onward, can now be seen. As compared with the white marble headstones from Vermont it is more durable; and there is not so luxuriant a growth of moss and lichen as on the latter stone, but in the case of the older

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[1] The Commercial Marbles of Western Vermont. U. S. Geol. Survey Bul. 521, 1912, p. 38.

[2] Building Stone in New York. N. Y. State Museum Bul. 10, 1890, p. 237.

Gouverneur stone some signs of decay and disintegration, particularly on the tops, are noticeable, and small pieces can be chipped off with a knife blade. The durability of the stone for building purposes has been tested in some of the older structures in Gouverneur.

PHYSICAL PROPERTIES

Marble is heavier than granite and has a specific gravity ranging from about 2.70 in the case of calcite varieties to 2.88 for dolomites. These figures correspond to weights for each cubic foot of from 168 to 180 pounds. The South Dover white marble, a nearly pure dolomite, has a specific gravity of 2.86 and a weight of 178.5 pounds; the Gouverneur slightly magnesian blue marble possesses a specific gravity of 2.74 and a weight of 171 pounds for each cubic foot.

The compressive strength of marble varies within rather wide limits according to the textural features. Merrill[1] credits the Pleasantville coarse dolomite with the very high crushing strength of 22,383 pounds a square inch. The Tuckahoe marble, according to the same authority, gave a test of 13,076 pounds. Both figures refer to the strength when tested across the bed. Three samples of marble from the quarries of the South Dover Marble Co. showed a minimum compressive strength of 17,401 pounds and a maximum of 20,882 pounds.[2] These results compare well with those obtained from the best building marbles of other districts.

The Gouverneur marble, represented by a sample from the quarries of the St Lawrence Marble Co., showed a strength under compression of 12,692 pounds a square inch.[3]

Tests of transverse and tensile strength are rarely made, though they afford useful data in estimating the coherence and durability of marble.

GEOLOGY OF THE NEW YORK MARBLES

The metamorphic phanerocrystalline limestones, which include all marbles in the true sense, as already explained, occur only in regions where the rock formations have been squeezed, folded and upraised into mountains. Originally they were horizontally bedded, common limestones accumulated on the floors of the ancient seas by the slow aggregation of the shells of organisms that lived in these waters and in part perhaps by direct chemical precipitation

[1] Stones for Building and Decoration. New York, 1897, p. 461.

[2] Twentieth Annual Rep't U. S. Geol. Survey, pt 6, cont'd. 1899, p. 422.

[3] *Op. cit.*, p. 423.

of lime carbonate from solution. The formation of limestone by similar methods is going on today along the sea coast, as exemplified by the shell beds, coral reefs and calcareous muds which are widely distributed and which require only consolidation from the weight of overlying strata and uplift from the sea to convert them into limestones similar to those exposed in the early Paleozoic formations of New York State. The deposition of lime carbonate in quantity also takes place in fresh waters; the beds of marl found in many swamps and lake basins of this section are the result of precipitation of lime which has been brought in by tributary streams and springs, the lime being thrown out of solution sooner or later by evaporation of the waters or through the agency of plant growth. There are many thousands of acres of these surface marls in the central and western parts of the State.

The conversion of common limestone into marble requires great pressure, which in nature is developed through those crustal movements that lead to the formation of folded mountains; under the stress thus exerted, accompanied by heat and probably in the presence of moisture, the lime carbonate behaves like a mobile or plastic substance and is able to assume its proper crystal character, that of calcite. Each particle becomes a complete crystal, with the characteristic cleavage, optical properties and other features of calcite, though owing to the space limitations it can not assume the outward regularity of form which belongs to calcite when free to expand in all directions. The change, or metamorphism, is accompanied also by a rearrangement and crystallization of the impurities, as has already been noted.

There are two areas in New York where crustal movements have taken place on a great scale during past geological ages. The Adirondacks in the north are a part of the old Laurentian highland which was uplifted in early Precambric time and subjected to great vicissitudes of compressive folding, faulting and invasions by igneous rocks before the regular stratified formations began to be deposited. In the southeast is the Highlands-Taconic region, of which the Highlands proper represent a part of the old Appalachian highland of Precambric age, and the Taconic a later uplift that came at the close of the Ordovicic period.

THE ADIRONDACK SECTION

The crystalline limestones of the Adirondacks appear in belts, elongated in a general northeast-southwest direction parallel to

the structural trend, and in smaller patches of variable shape and extent which have a very unequal distribution. They are rather abundantly represented on the eastern side in Essex and Warren counties, but mainly as scattered areas that cover a few square miles each at most. On the north in Clinton and Franklin counties are a few outcrops, and these unimportant; and the same may be said of the Southern Adirondacks included within Saratoga, Fulton, Herkimer and Lewis counties. The principal development of the limestones is on the northwest, in St Lawrence and Jefferson counties, outside the rugged mountain section but within the Precambric crystalline formations which here extend outward across the St Lawrence lowland and connect with the main Canadian expanse of the rocks. Four considerable belts of limestones, besides numerous smaller lenses and patches, exist in this section as may be seen by consulting the St Lawrence sheet of the State geologic map. Detailed information as to their extent and general features has been given by C. H. Smyth.[1] The most important exposure, areally and economically, has a length northeast and southwest of about 35 miles, extending from the town of Canton, St Lawrence county, to near Antwerp village in Jefferson county, with a width of from 1 to 7 or 8 miles and an area of 175 square miles. A parallel belt occurs a few miles northwest, about midway between its border and the St Lawrence river, and has a length of 15 miles, lying in the towns of Macomb, Hammond and Rossie, St Lawrence county, and Theresa, Jefferson county. Southwest of the main area is the Edwards-Fowler belt of St Lawrence county, notable for its talc deposits. The fourth belt lies farther southeast across the St Lawrence-Lewis county boundary, being partly in the town of Pitcairn of the former county and partly in the town of Diana of the latter. It is about 20 miles long and perhaps 2 or 3 miles wide as a maximum.

The belts are not wholly constituted of carbonate rocks, but include more or less quartzite, schist and gneiss which have the appearance of being interbedded with the limestones. Altogether the different formations represent the metamorphosed and deeply eroded remnants of what once must have been an extensive and varied series of sediments. The series included sandstones now changed to quartzites, arkose which has become quartzose gneisses,

[1] See especially, Report on the Crystalline Rocks of St Lawrence County, N. Y. State Museum Annual Rep't 49, v. 2, 1898, p. 481–90.

shales now altered to mica schists, argillaceous limestones that have become basic gneisses and amphibolites, as well as pure carbonate materials that are now marbles. The sediments at one time, no doubt, spread over the whole Adirondack region, and the present irregular and patchy distribution is the result of extensive erosion upon the formations which at different times were also invaded, broken up and to some extent absorbed by the great igneous masses which came up from below.

The metamorphosed sediments exhibit very similar features and relationships wherever found in the Adirondacks, so that they are regarded as members of a single geologic series, which is called the Grenville series from their analogy with the Canadian formations that bear that name. Little is known as to their time-relations beyond the fact that they antedate all the other Adirondack rocks, and consequently must have been laid down very early in the Precambric period. Subsequent to their deposition, but before the opening of Cambric time, there was a long era characterized by intervals of great igneous activity in which granite, anorthosite, syenite, gabbro and finally diabase were erupted. None of the members of the Grenville carries recognizable fossil remains, though the abundance of graphite in some of the strata, particularly the quartzites, leads to the inference that life existed at the time.

In most of the belts the limestones and the accompanying schists, quartzites and gneisses are tilted and present their upturned broken edges at the surface. The angle of inclination is usually high, dips of less than 30° being exceptional, whereas a nearly vertical attitude is quite common. The strike is nearly always between the north and easterly compass points, in most cases nearly northeast, but is subject to local variations. The beds over large areas may maintain monoclinal arrangement, with the inclination in the same direction; this is the common condition in fact, as few instances have come to notice where the dips of adjacent belts are in opposite directions. The general high inclination and the presence of minor folds seem to indicate, however, that the beds are not simply tilted up by a great monoclinal flexure, but that they have a much more complicated structure through the presence of anticlinal and synclinal folds strongly compressed. The actual relations that exist in any of the belts can not be stated at the present time, and it is still uncertain just what the order of the sedimentary succession may be.

The St Lawrence county belts are much broken by irruptive masses, of mainly granitic nature. These rocks have a massive to

gneissoid appearance, but lack the schistosity of the Grenville gneisses, are prevailing reddish or gray in color and belong mostly to the biotite and hornblende varieties of granite. They form bosses of some size and also sills and dikes, while small offshoots cut through the sedimentary gneisses in a network of interlacing veins. They exert noticeable contact effects upon the limestones which in their vicinity may contain such minerals as tourmaline, vesuvianite pyroxene, tremolite, fluorite etc., often well crystallized.

THE GOUVERNEUR MARBLE

The crystalline limestone in the area about Gouverneur has furnished most of the marble that has been quarried in the Adirondack region. The area is a part of the belt which extends from the town of Canton, St Lawrence county, to near Antwerp, in Jefferson county, and which is traversed for much of the distance by the R. W. & O. branch of the New York Central Railroad.

The limestone in general is medium to coarse crystalline and white or light gray in color, but sometimes a dark blue as in one or two of the quarries. It is a calcite limestone, with a varying but generally small percentage of magnesia. The carbonates amount to about 95 per cent of the whole mass, of which nearly 90 per cent is calcium carbonate. Rarely the magnesia assumes sufficient importance to characterize the rock as a dolomite. The change from a calcite-limestone to dolomite takes place abruptly, but whether it reflects an original variation in the conditions of deposition or is due to secondary processes after the strata were laid down, is not clear. In the former case it would be expected to find the variation related to the bedded structure, but such relation can not be established. The occurrence of dolomite is quite local and unimportant as compared to the great body of limestone. On the other hand, the limestone shows well-marked zones or bands parallel to the bedding in which quartz is abundant and which seems to be the result of impurities included when the rock was being deposited.

The following analyses illustrate the chemical composition of the Gouverneur marbles. No. 1 is based on a sample from the Extra Dark quarry of the St Lawrence Marble Quarries; no. 2, quarry of the Gouverneur Marble Co; no. 3, Rylestone quarry; and no. 4, Northern New York quarry. No. 5 represents the dolomitic marble, formerly worked by the White Crystal Marble Co. Nos. 1, 2 and 3 are by R. W. Jones of the State Museum.

	1	2	3	4	5
Insol.	3.55	1.26	1.01	......	......
SiO_2	......	......	......	1.58	.28
Al_2O_3	.13	.65	.23	.79	.10
Fe_2O_3	.08	.29	.63		
MgO	......	......	......	3.49	20.64
$MgCO_3$	6.40	7.50	6.85	......	......
CaO	......	......	......	51.45	31.45
$CaCO_3$	87.06	87.47	88.94	......	....
H_2O	1.68	1.46	1.74	......	......
CO_2	......	......	......	42.56	47.38
S	.05	.02	.04	.03	.06

The Gouverneur marble is quarried from a small area southwest of that town. The quarries, with few exceptions, lie along a narrow belt which extends for a little over a mile in a northeast-southwest direction. They lie on the outcrop of the "vein" or bed which dips northwest at an angle ranging from 15° to 30° on the northeast end to 80° or 90° in the southwesterly quarries. The vein has a pitch that is toward the southwest at an angle of 20° or 25°. There is some suggestion in the field relations that the marble occurs along an overturned pitching fold.

In color and texture the marble shows variety, though the differences in composition are not especially prominent. It is a mottled white and grayish blue, or light and dark blue, running in places to an almost solid dark blue, which is the color most sought for. In the lighter mottled sorts the grain is moderately coarse and somewhat uneven, with the lighter and darker calcite segregated more or less into separate areas. The individual calcite particles mostly have a diameter from 1 to 2 mm. In the dark-blue marble, the grain is much finer, the calcite averaging only a fraction of a millimeter. The bluish color seems to be traceable to the presence of graphitic carbon in very small submicroscopic particles. Free carbon was detected by R. W. Jones in the analyses already given, but in too small amount to be separately weighed. That the variation of color conforms more or less closely to the bedding is evident from a study of the relations revealed in the different quarries. The lighter colors are found in the overlying beds of the northwestern section, and the fine-grained dark marble is from the structurally lower beds on the southeast. This feature has been confirmed as well by the results of core-drilling.

The marble is susceptible of high polish and has a luster and texture that resemble some gray granites. It is well adapted for monumental work and the better grades are used mainly for that

Extra dark quarry of the St Lawrence Marble Company. At left a vertical trap dike is seen, forming a wall between the two openings.

purpose. Its weathering qualities are attested by nearly a century of use as monumental and building stone. For building stone it has found considerable sale in the large towns and cities of New York and adjoining states, especially for public structures, churches

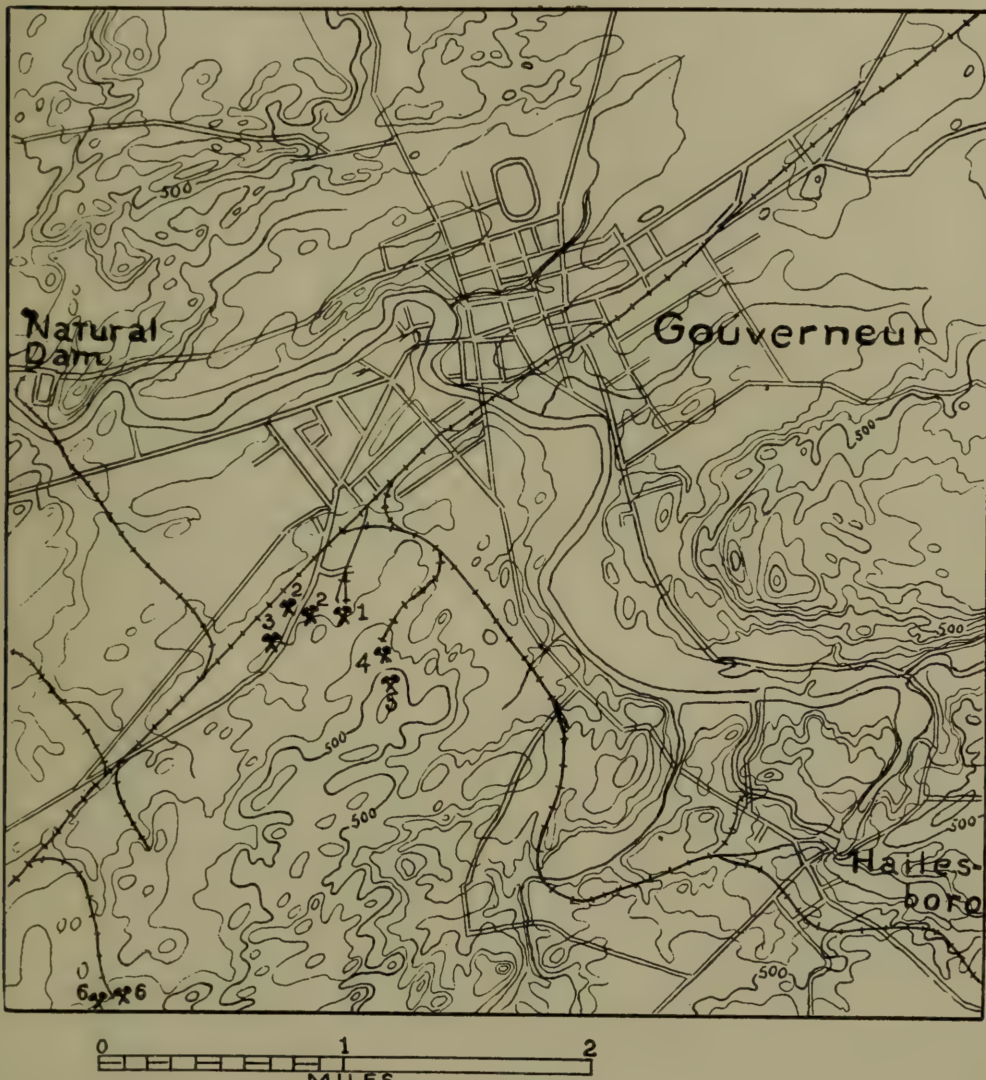


Fig. 14 Map of marble district near Gouverneur. 1 is Gouverneur; 2, St Lawrence; 3, Sullivan; 4, Callahan; 5, Extra Dark; 6, Northern New York quarries

and fine residences. In rock face, as used for building stone, the marble has a medium gray color, whereas the cut or patent hammered surface of trimmings shows much lighter. The selling prices vary with the color and uniformity.

Determinations of the specific gravity and absorption of the

Gouverneur marble gave the following results: specific gravity, 2.74; corresponding to a weight of 171 pounds to the cubic foot; ratio of absorption .111 per cent; pore space, .305 per cent.

The St Lawrence Company's quarries

The quarries of this company include two openings near the mill and railroad track, a little more than a mile southwest of Gouverneur, and a third lying to the east on a separate vein. The latter, known as the Extra Dark quarry, alone was in operation

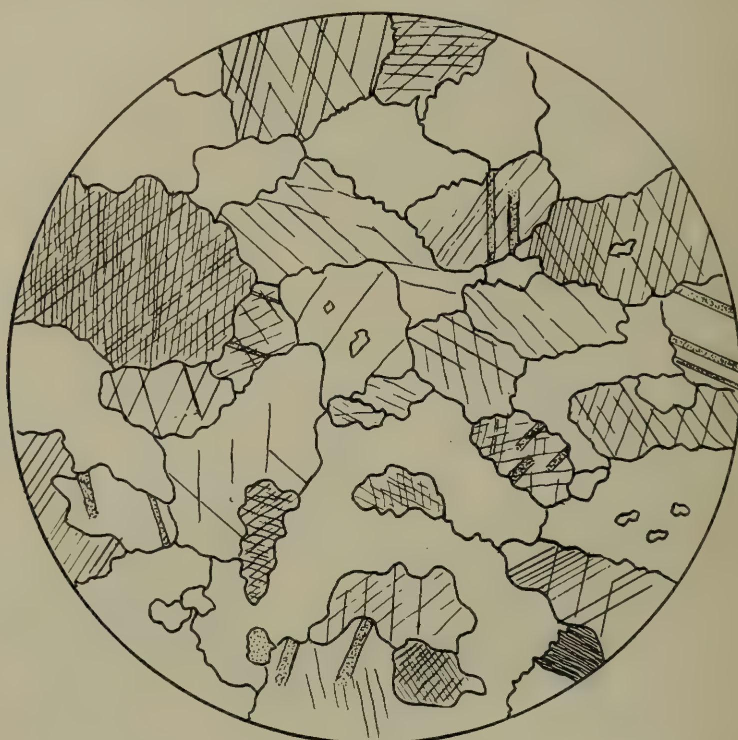
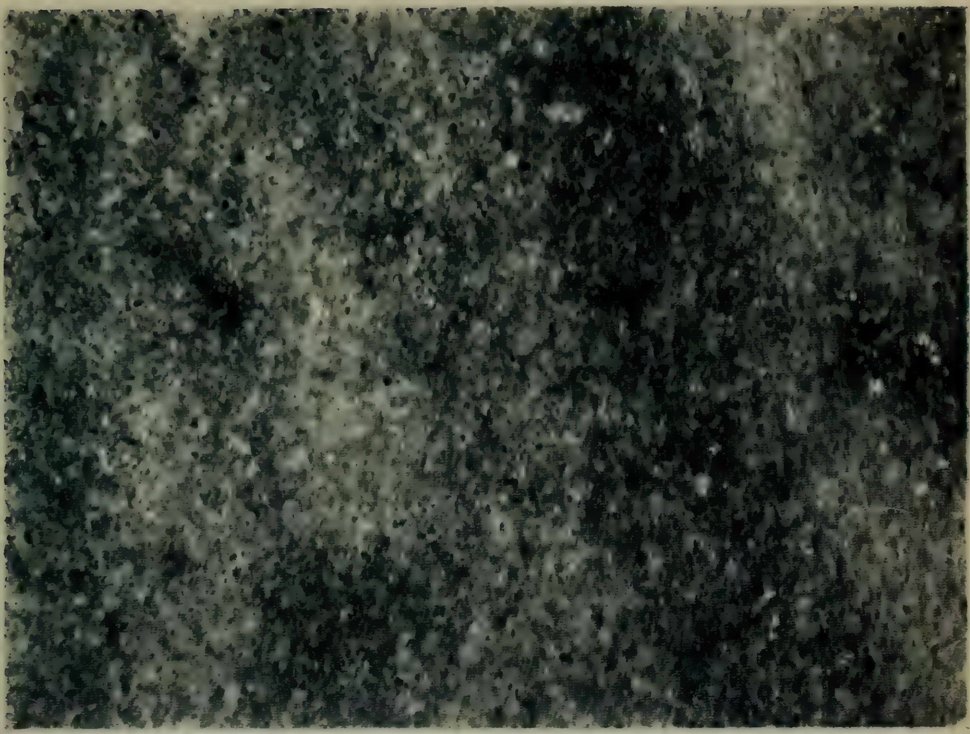


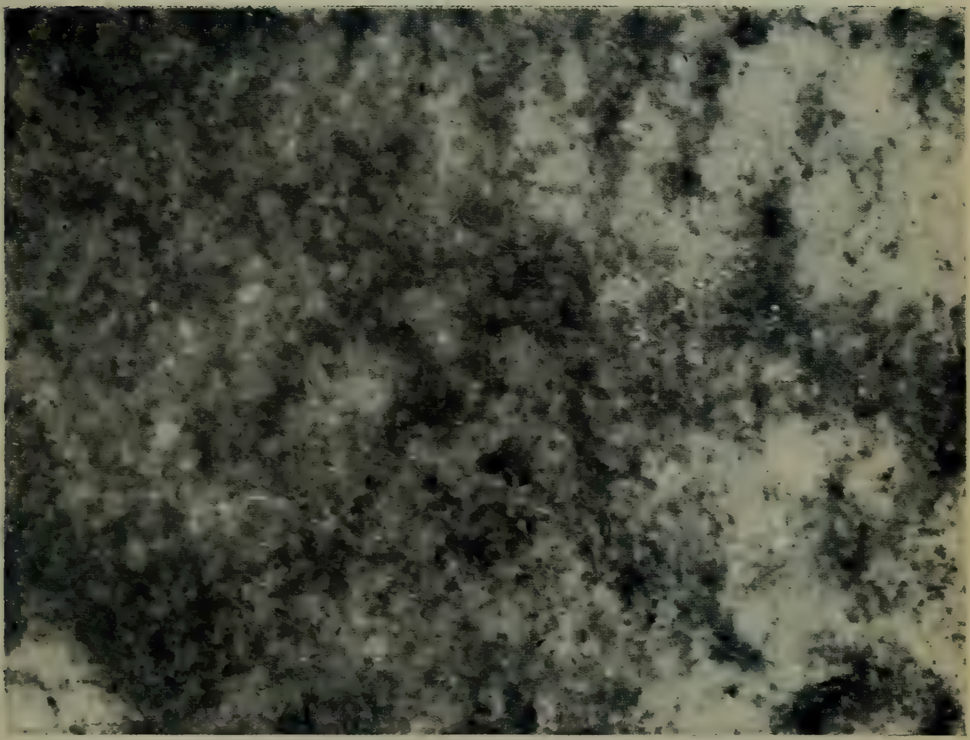
Fig. 15 Gouverneur marble in thin section, showing the irregular boundaries between the particles and firmly interlocked texture. Enlarged 25 diameters

at the time of the writer's visit in the fall of 1912. It is an opening 125 feet long, 80 feet wide and 20 to 30 feet deep. At the surface the marble is of medium bluish color somewhat mottled with white, but becomes dark blue below, which is the grade particularly sought, as the other quarries supply lighter stock. The beds dip northwest 30° and pitch southwest 25°. Two vertical joint systems running N. 30° W. and N. 65° E. are in evidence. As shown in the accompanying illustration, the quarry is crossed by a vertical trap dike which is left standing as a wall; the dike

Plate 27



Dark gray marble. Gouverneur



Mottled gray marble. Gouverneur

follows the northeasterly jointing and is from 2 to 3 feet thick, consisting of a serpentinous groundmass with lath-shaped feldspars.

The two openings near the mill, known as the St Lawrence quarries, are vertical rock cuts with an area of about 20,000 square feet each and a depth of 80 feet in the northerly quarry and 40 feet in the southerly one. They have supplied large quantities of building marble, of which examples are seen in the First Presbyterian church, Gouverneur; Grace church, Watertown; Jay Gould Memorial, Roxbury; Third Presbyterian church, Rochester; and in many other structures. For building purposes it is mostly used as rock face ashlar which has a bright gray color. The monumental stock is mainly the selected darker quality that is sold under the name "St Lawrence" but includes some lighter stone called "Adirondack." The beds here dip about 20° to the northwest. They have been penetrated to a depth of 400 feet in a drill hole near the cutting works.

The quarry equipment includes six channeling machines, two gadders and three derricks. The mill has sixteen gangs of saws, besides rubbing beds, lathes, and polishing machines. Electric power is used, supplied by the Hailesboro water power plant.

A chemical analysis of the marble from Extra Dark quarry is found on page 186.

The company states that the marble has a specific gravity of 2.76, corresponding to a weight of 172 pounds to the cubic foot. The ratio of absorption is .160.

Gouverneur Marble Company's quarries

The Gouverneur Marble Company owns quarries in the northeastern section of the marble belt, adjoining the property of the St Lawrence company. The principal one is a cut about 250 feet long and nearly as wide, with a depth of about 50 feet. A new opening 125 feet long and 50 feet wide has been made just southeast of the large quarry with which it will eventually be connected. The bedding here dips very low to the northwest. The jointing is in two systems, N. 40° W. and N. 50° E. which with the floor seams divide the marble into rectangular blocks. A test hole in the new quarry penetrated the marble to a depth of 95 feet.

The product runs mostly to the medium and light varieties, but the new opening shows considerable darker marble from the underlying beds. The grain is moderately coarse, with a grain diameter

of 2 to 3 mm. There is a little phlogopite in small but visible scales distributed through the carbonates. The marble from these quarries is often beautifully mottled and such material is used in polished work. As a building stone it has been employed in many large structures, notably in the Sacred Heart and St Anthony's churches in Syracuse, and the high school in Schenectady.

The mill, situated near the quarries, is equipped with eleven gangs of saws.

Northern New York Marble Company's quarries

The property of the Northern New York Marble Co. lies in the southwestern section of the Gouverneur district separated from the other quarries by a considerable stretch of undeveloped ground. Its position is east of the extension of the line connecting the more northerly openings, which indicates that it is on a lower vein structurally than the others. Otherwise there must be a fault or a wide deviation of the strike in the interval. There is some similarity in the character of the marble with that of the Extra Dark quarry of the St Lawrence company, which lies on the footwall side of the main belt. The strike of the beds here is N. 70°–80° E. and the dip 80° north.

The main quarry measures 140 feet by 75 feet at the surface and is over 200 feet in depth. It has been abandoned on account of the depth. A second quarry 100 feet south has furnished the recent output; it is an opening 120 feet long and with a depth of from 40 to 65 feet. In 1912 the development of a third quarry was begun, situated to the west of the latter, with which it will eventually connect. The quarries are equipped with two derricks and have the usual oufit of channelers and gadders.

The marble has a dark blue color for the most part, averaging much darker than the usual Gouverneur product, and is also finer textured. The grain diameter ranges from 0.5 to 1 mm in the darkest samples. As shown by the analysis on page 186, it is a high grade magnesian limestone with only about 2 per cent impurities. The product is sold under the name of "Northern New York" and is graded according to the presence or absence of lighter veins or clouds in the dark blue ground. It is mainly in demand for monumental work. A good proportion of the lighter quality is hammer-faced, not polished, a finish which gives the appearance of tooled granite.

Plate 28

Shipping yard and mill of St Lawrence Marble Company

In the quarry walls a few knots from silicate inclusions are in evidence; they rarely exceed a foot in diameter. Open joints and fissures occur in the upper 15 feet where the marble is more or less discolored and disintegrated, but below the stone is fresh, uniform and little broken by joints. The surface has been polished and in places is deeply grooved by glacial ice.

The Rylestone quarry

The Rylestone quarry, worked up to a short time ago, lies west of the main belt, a mile or more, on the side of a low ridge. It was not operated in 1912 when inspected by the writer. The marble is bluish gray, with an equal mixture of white and blue calcite. The grain is fine to medium, the particles ranging from 1 to 3 mm in diameter. The texture is rather uneven. Apparently there has been considerable loss in quarrying from the presence of vugs, which are apt to occur in the midst of an otherwise sound block. These vugs take the form of small round cavities and of seams a foot or more long and are lined with crystallized calcite, marcasite and brown tourmaline.

The quarry face extends along the base of the hill for 100 feet and is 50 feet high. In the last operations the stone was broken down by blasting, which has left much waste. A mill equipped with eight gangs of saws is situated on the property.

Other quarries near Gouverneur

The John J. Sullivan quarry, now closed, is situated 500 feet west of the St Lawrence quarries. The pit is about 100 feet long and 50 feet wide. The marble exposed on the edge near the surface is coarse-banded, white and blue, of rather light appearance. Some of the beds show disseminated scales of mica, tremolite crystals and other silicates. The quarry equipment has been dismantled and the pit allowed to fill with water.

The Callahan quarry is a small opening near the Extra Dark quarry of the St Lawrence company. The marble is of medium, bluish gray color and moderately coarse texture. The quarry was last worked five or six years ago.

The D. J. Whitney quarries lie near those of the Northern New York Marble Co. They have yielded considerable quantities of medium to dark-colored stock, used for monumental work. They have been inoperative for several years.

The White Crystal Marble Co. opened a quarry about ten years

ago in the vicinity of Gouverneur for the supply of building material. The stone has a coarse texture and is pure white. The analysis on page 186 shows it to be a dolomite. Physical tests made at the Watertown Arsenal (Mass.) indicated the crushing strength of one sample to be 25,250 pounds to the square inch; of another sample 23,070 pounds to the square inch. This is well above the average of most marbles, and the stone is probably equal to any practical requirement in regard to strength. The quarry is owned by C. A. Lux of Syracuse.

Furnace flux is shipped by Corrigan, McKinney & Co. from a quarry situated 2½ miles north of Gouverneur, the output going to the company's furnace at Charlotte.

FOWLER, ST LAWRENCE COUNTY

A white, coarse dolomitic marble occurs in the town of Fowler as a part of the belt of crystalline limestones which inclose the talc beds of that section. An extensive exposure of the brilliant white stone is found on the Abbott farm just west of the hamlet of Little York. It has been worked to some extent by A. B. Scott, principally for shipment to makers of artificial stone. The marble is free of stain and can be obtained in large blocks. According to information supplied by Mr Scott, the stone shows 18 per cent magnesia (MgO) and about 8 per cent of foreign matter.

CANTON, ST LAWRENCE COUNTY

An active marble-quarrying industry was conducted a few years since in the northeastern section of the limestone belt, south of Canton and in some of the small outlying areas of limestone in that part of St Lawrence county. An account of some of the later operations has been given by W. N. Logan.[1]

The E. E. Stevens quarry is 1½ miles southwest of Canton village. The stone has a grayish color, with a close resemblance to gray marble on cut surfaces. The output in the years preceding 1902 was valued at $40,000 annually.

The Nickerson quarry is mentioned by Stevens as containing a light yellow marble with serpentine inclusions. It is on the Nickerson farm 2 miles south of Canton village.

White marble was produced at one time in the Clarkson quarry, near DeKalb Junction. The output in the last year of operations is placed by Logan at $15,000.

[1] 23d Report of the State Geologist, 1904, p. 118–19.

Plate 29

Gouverneur Marble Company's Quarry

The small area of crystalline limestone near Colton, south of Potsdam, has been developed in one or two places for marble. One quarry is situated on the Peter Fallon farm, about 2 miles east of Colton village, and another on the farm of J. C. Leary in the same vicinity.

HARRISVILLE, LEWIS COUNTY

Building and monumental marble has been quarried on a small scale in years past at Harrisville, Lewis county. The quarry is about 500 feet north of the railroad at the base of a low hill and consists of an opening 75 feet square. It is an indistinctly banded grayish marble, light in tone, and rather coarse, with a grain diameter of 1 to 3 mm. The banding apparently is a bedding feature, the darker bands containing a higher percentage of impurities than the lighter ones. The direction of the banding is northeast-southwest and the dip 40° northwest. The impurities, which consist of serpentine, pyroxene and some sulphides, would seem to be a drawback to the use of the stone for polished work. An analysis of an average sample made by R. W. Jones gave the following percentages:

SiO_2	1.64
Fe_2O_3	.04
$MgCO_3$	21.79
$CaCO_3$	76.17
	99.64

NATURAL BRIDGE, LEWIS COUNTY

Quarries have been opened in the crystalline limestones in the vicinity of Natural Bridge for the manufacture of lime. The limestones are coarse, dolomitic and as a rule not adapted for cut stone.

The New York Lime Co. has carried on operations for several years in a quarry at Sterlingbush, north of Natural Bridge, and also at the latter place and at Bonaparte Lake where the dolomites attain a degree of purity requisite for lime manufacture. The product is mainly sold to pulp manufacturers for use in the sulphite mills.

THE HIGHLANDS — TACONIC AREA

Crystalline limestones occur in many places in the Highlands region and in the bordering metamorphic area to the north and south. They are specially prominent on the east side of the Hudson where they underlie many of the north-south stream valleys of

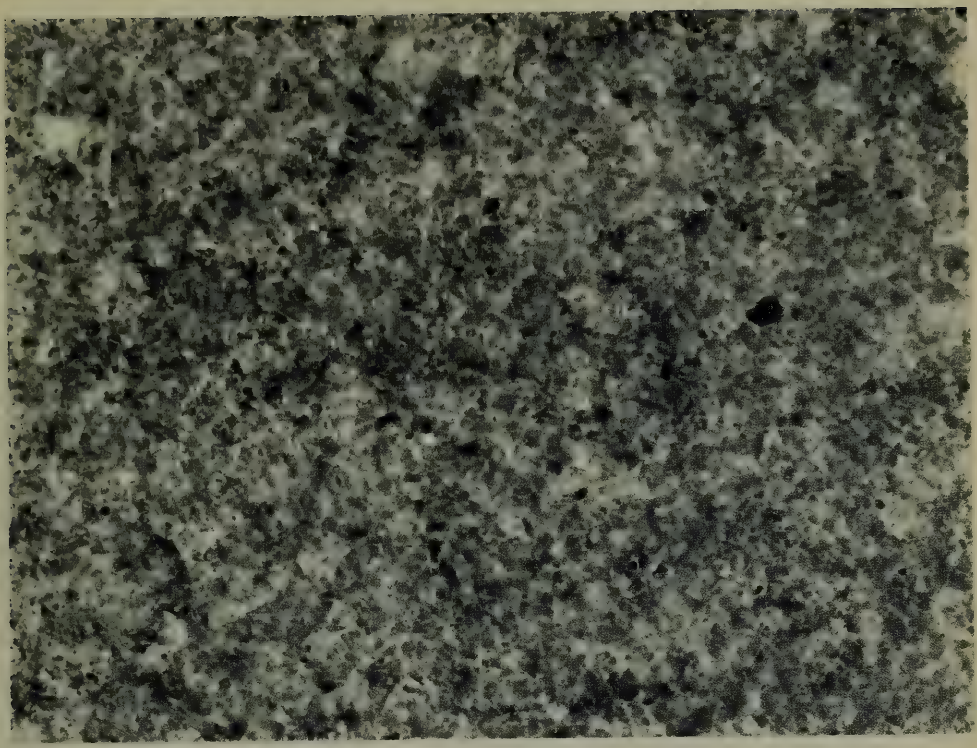
Westchester, Putnam and Dutchess counties, but also occur in Orange county as a continuation of the northern New Jersey belts. Those of a thoroughly crystalline character are associated with schists, quartzites and thin-bedded gneisses, forming a series of interfolded metamorphosed sediments that bear some resemblance in certain aspects to the Grenville series of the Adirondacks. Their stratigraphic position is doubtful; it would appear that they may represent more than one period of formation, as indicated by the varying degree of metamorphism which they have undergone.

In Westchester county the limestone is coarsely crystalline, white, and usually carries magnesia in proportions characteristic of dolomites, though in the very northern part of the county there are limestones with low magnesia. The name "Inwood" was first applied to the limestones by F. J. H. Merrill, who later advocated the view of the general equivalence of the limestones in this section with those of western New England and withdrew that name in favor of the prior term "Stockbridge" limestone. Merrill and other geologists have regarded the Westchester county limestones as a southerly extension of the belts that are found north of the Highlands where they are much less metamorphosed and are known to be of Cambro-Ordovicic age.

More recently Berkey has indicated the possibility of the existence of two main series of limestones. The Westchester county representatives, accompanied by the Lowerre quartzite and Manhattan schist, show no marked unconformity with the underlying gneisses, and are considered as Precambric. The second assemblage includes the less changed types of white and blue limestones, developed mainly to the north of the Highlands, which have been known as the Wappinger limestone and which are associated with the Poughquag quartzite and the Hudson River slates. These show a marked unconformity in contact with the gneiss formation. Small bands and lenses of impure limestone occur within the Highlands gneisses, and are probably the oldest of all, that is of Grenville age. The latter have little economic importance.

The crystalline limestones of southeastern New York are prevailingly high in magnesia, though there are some localities where they carry under 5 per cent. In the developed marble quarries the stone is usually a true dolomite. The proportion of lime carbonate ranges from 55 per cent as a lower limit to about 70 per cent, while the magnesium carbonate amounts to from 30 to 45 per cent. The siliceous impurities are usually low, not over 2 or 3 per cent of the

Plate 30



Dark gray marble. Gouverneur

Green marble (Ophicalcite). Moriah, Essex county

whole. They are due to inclusions of quartz, mica, tremolite, diopside and more rarely tourmaline.

The building marbles are found in the more massive, heavily bedded parts of the formations. They are predominantly white, either a uniform brilliant white, or white clouded or banded with blue. They are used both for exterior and interior work. Examples of their architectural employment may be seen in many large structures in New York City, especially among the buildings erected twenty or more years ago, as at that time the Westchester county stone enjoyed greater favor among architects than any other native marble.

In durability, the dolomitic marbles from southeastern New York show considerable variation, as has been remarked in the discussion of weathering qualities. Some of the stone is ill-adapted to building purposes on account of the fact that certain phases show a sugary, loosely bonded texture and decay rapidly when exposed to the elements. It is unfortunate that such stone should ever have been employed in buildings. On the other hand, the product of many of the quarries has proved, under the rather trying conditions of the eastern cities, to be an excellent architectural stone, equal in weathering qualities to any of the other marbles in common use. Rapid weathering apparently does not result from any peculiarities in the composition of the stone, but depends upon a lack of coherence and compactness whereby the mechanical influences of frost and temperature changes are enabled to destroy the bond. Normally, dolomite is harder and more resistent to the attack of solvents than calcium limestones.

DOVER PLAINS, DUTCHESS COUNTY

Marble for building and ornamental purposes was once quarried near Dover Plains. The ledges may be seen along the east side of Tenmile creek southeast of the town. One of them is now the site of an active quarry which is worked by the Dutchess County Lime Co. for the manufacture of lime. The stone is a fine but rather loosely grained dolomite, blue or white in color, and quite free of silicates. The dolomite grains are round and not firmly welded, so that they weather out readily when the stone is exposed to the atmosphere. The beds in this section strike about N. 10° E. and stand on edge or are inclined to the east at an angle of 80° to 85°. The color changes abruptly from white to blue across the strike, apparently with the different beds. With its low percentage of soluble matter (2 to 3 per cent), the stone is well adapted for making magnesian lime.

WINGDALE, DUTCHESS COUNTY

South Dover Marble Company's quarries

The South Dover Marble Co. has large marble quarries 2 miles in a direct line northeast of Wingdale station on the Harlem Rail-

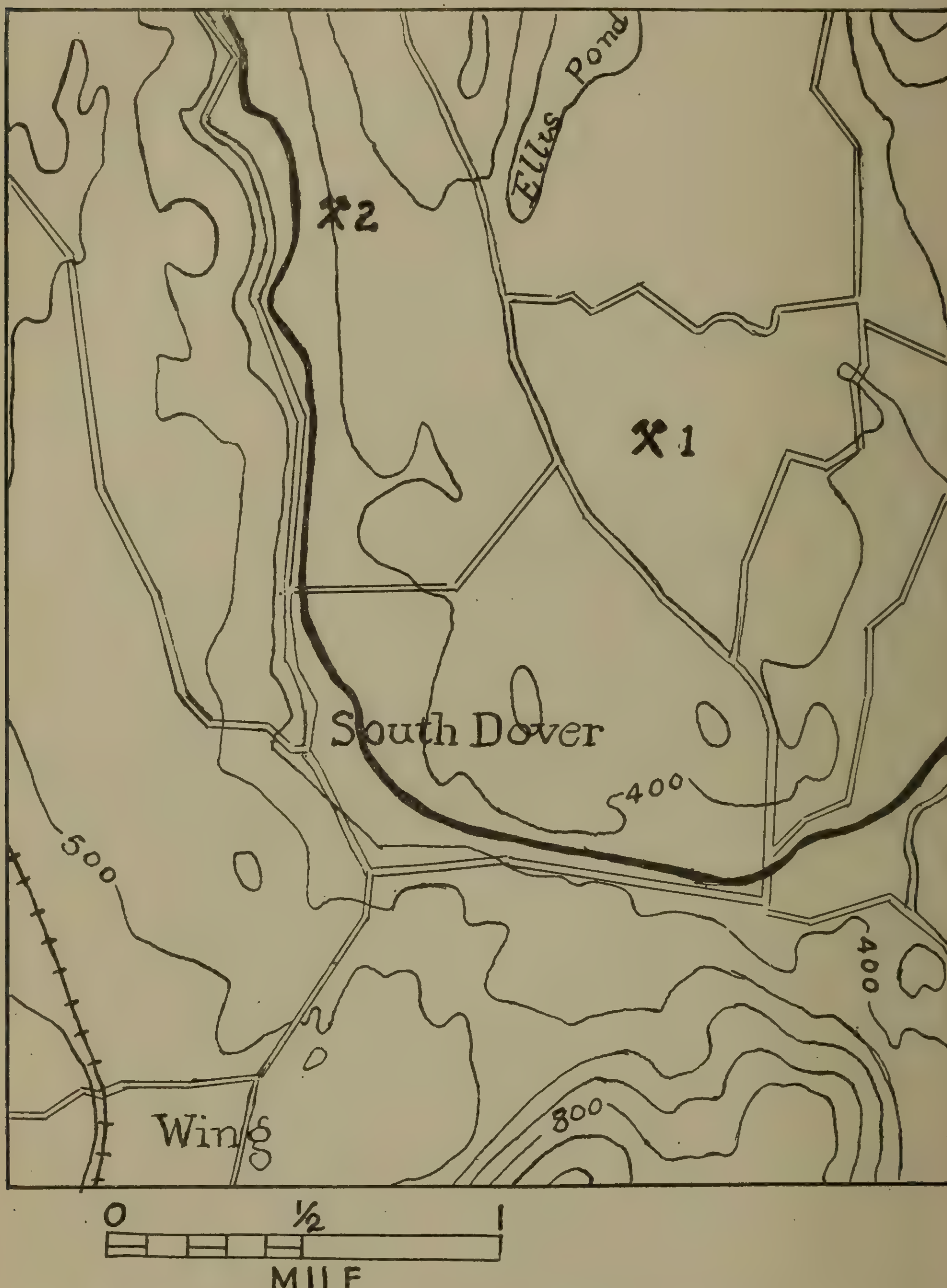


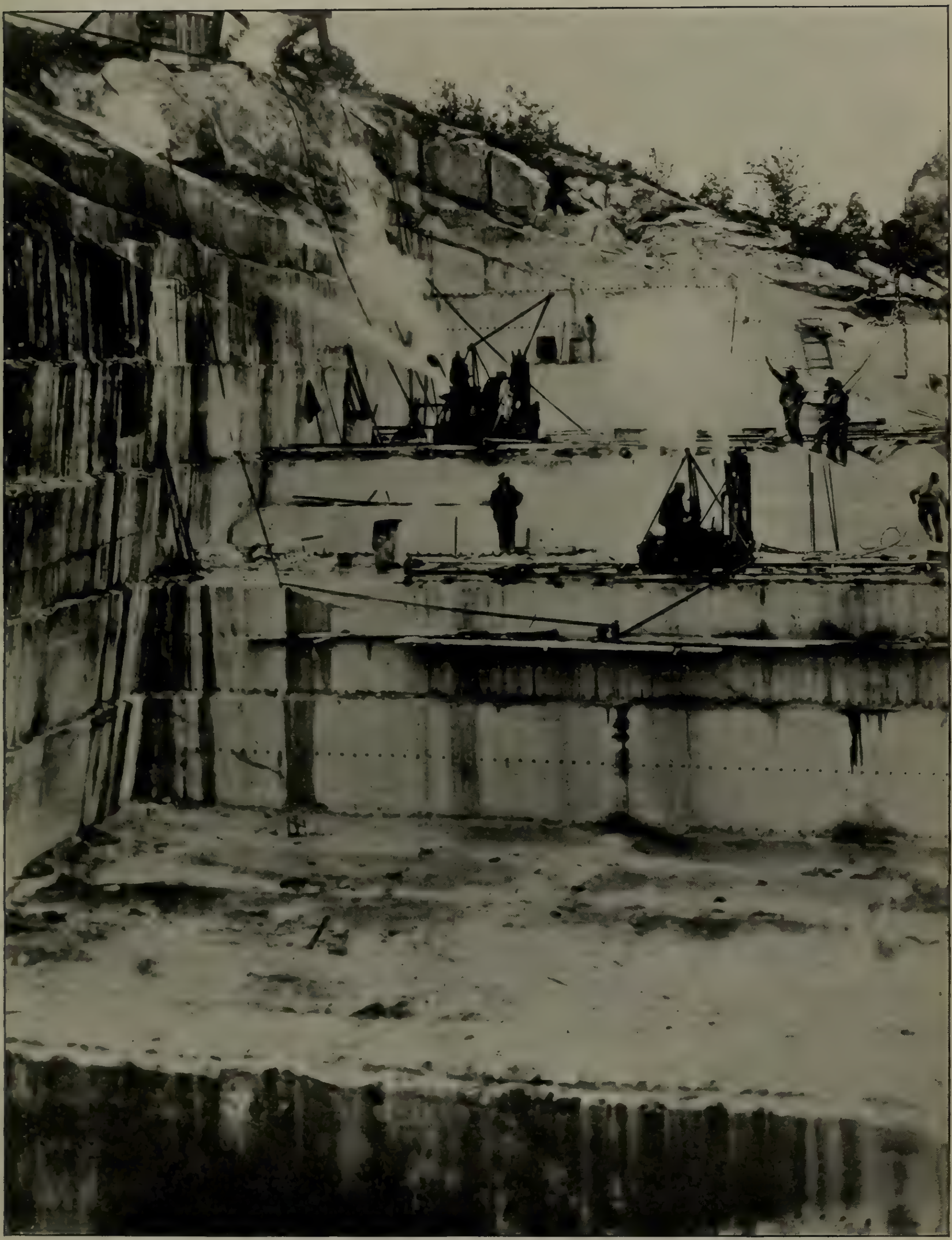
Fig. 16 Map of South Dover quarries. 1 is South Dover; 2, Dover White quarries

road. The belt of crystalline limestone in which lie the quarries stretches along the flanks of a broad gneiss ridge which extends

Plate 31

The main quarry of the South Dover Marble Company, Wingdale

Plate 32



Upper quarry of the South Dover Marble Company, Wingdale

north and south on the New York–Connecticut boundary. The surface is flat or slightly hilly in contrast with the rugged outcrop of the gneiss. The limestone maintains a nearly uniform course slightly east of north and shows usually an easterly inclination, but for short distances the dip may change to the west. Along with the limestone appears a white quartzite that may be seen a little to the west of the quarry openings.

The product of the quarries is a uniform white marble suited for building and interior work. The grain is fine; the particles average from .75 to 1 mm diameter and are prismatic or subrounded in form. In the exposed beds the marble appears very compact and, except for the upper few feet just below the soil, is neither stained nor weathered. Its appearance in thin section is shown in figure 17. Physical tests indicate a specific gravity of 2.86, ratio of absorption .144 per cent, and pore space .51 per cent. The weight is 178.5 pounds to the cubic foot. Strength tests made by Prof. Ira H. Woolson in the laboratories of the School of Mines, Columbia University, gave ultimate resistances to compression of 17,401 pounds to the square inch on one sample, 18,836 on another and 20,882 on a third, tested on the bed.[1] An analysis supplied by the company indicates that the lime and magnesia occur in the proportions of a true dolomite.

SiO_2	.70
Al_2O_3	.37
Fe_2O_3	.25
MgO	20.25
CaO	30.63
Na_2O	.12
K_2O	.46
Loss and undet	.56
CO_2	46.66
	100.00

The company has two quarries, the one being on the east slope of a low ridge facing the gneiss ridge and the second a little farther up the slope and northwest of the first. The lower quarry has an extreme length of 250 feet, a width of 150 feet as a maximum and a depth of 135 feet. There are three derricks in place. The other opening is 150 feet long, 75 feet wide and about 60 feet deep. It has two derricks and an overhead cableway, the latter for carrying

[1] U. S. Geol. Surv. 20th Ann. Rep't, pt 3, p. 422.

the waste to the dump. Both openings extend downward vertically, both with the bedding, which dips easterly about 40° in the south quarry and westerly 50° to 60° in the north, the dip reversing within a distance of 100 feet. There are few open joints or fissures, though one rather conspicuous opening in the southern quarry extends to a depth of 50 feet. There are occasional bunches of silicates and a little pyrite appears on some of the joint surfaces.

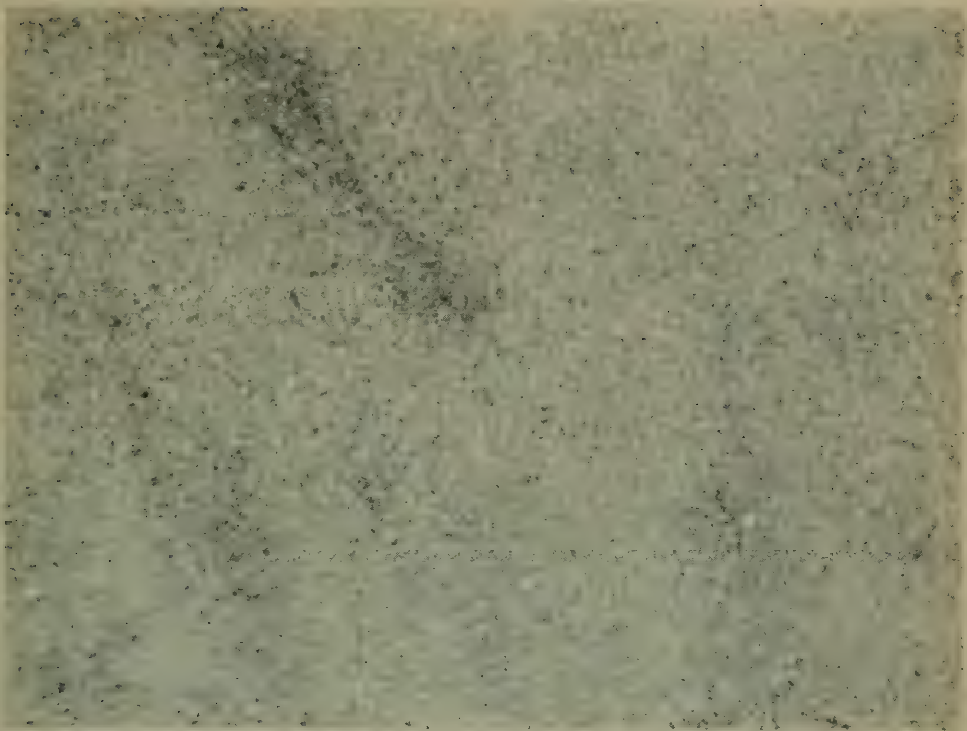
Fig. 17 South Dover marble in thin section. Enlarged 10 times

The South Dover Marble Co. has a cutting and polishing works at Wingdale station with which the quarries are connected by an electric tram. The product has been used in many large structures in New York and the eastern cities, and is one of the standard architectural materials of this county. Some of the important buildings in which it may be seen are the Tiffany Building, Blair Building, Stock Exchange (interior), Masonic Temple and Charles Building in New York, Essex County court house in New Jersey, Munsey Building and House of Representatives office building in Washington.

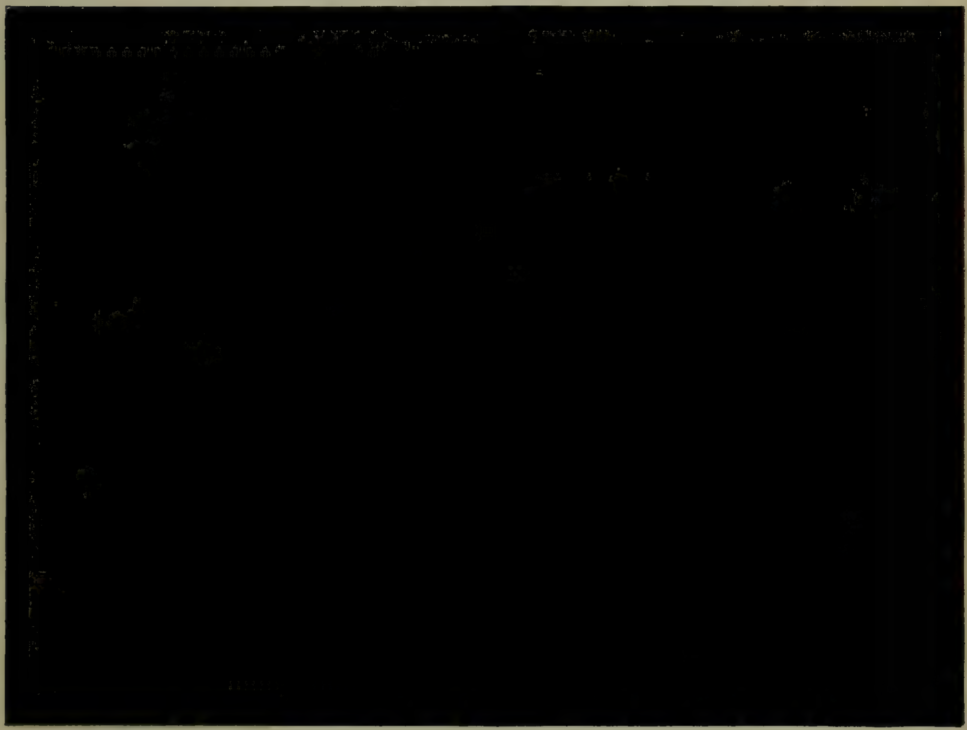
Dover White Marble Company's quarry

The quarry recently worked by the Dover White Marble Co. lies on the east bank of Tenmile creek 1½ miles northwest of the South Dover Company's quarry. It is a small side-hill opening in a white dolomitic marble which is streaked or banded with gray. The bands consist of quartz and sericitic layers, arranged parallel to the

Plate 33



Dover white marble. Wingdale, Dutchess county



Black marble. Glens Falls

bedding. They are somewhat wavy when seen in cross-section, as they have been subjected to powerful compression during the uplifting of the beds which stand nearly on end. The strike is about north and south and the dip 80° east. The bedding joints have been healed by flowage and crystallization of the carbonates, though still obscured in places as blind checks and seams. The marble has a fine grain with average diameters of less than .5 mm. The product has been employed mainly for veneer and wainscoting, for which purpose it is shown across the bedding so as to bring out the banding. The quarries were closed in 1912.

TURNER'S CORNERS, PUTNAM COUNTY

A gray marble was quarried at one time near Turner's Corners. The stone is rather coarse and in the outcrop shows a crumbly loose grain. It was employed in the dam at Sodus on the Croton water supply.

PEEKSKILL, WESTCHESTER COUNTY

A magnesian limestone of considerable purity and white to gray in color is found along Sprout Brook valley, north of Peekskill. It has been worked to some extent for lime, notably on the Frost place where there is a quarry and kiln, now idle. A sample of the stone selected to afford an average of the whole quarry face showed the following results, as reported to the writer by T. M. Williams (H. D. Gehret, analyst):

SiO_2	.70
Al_2O_3, Fe_2O_3	1.35
$MgCO_3$	6.00
$CaCO_3$	91.40
P_2O_5	.03
H_2O	.25
	99.73

The crystalline limestone continues northward into Putnam county and outcrops in force on the Couch, Slater and Barrett farms, in some places possessing a uniform white color and even texture like the best marbles of this region. The stone differs from the latter, however, in it relatively small magnesia content. Another analysis of the stone from the Couch farm, by H. D. Gehret, showed:

SiO_2	.90
Al_2O_3 / Fe_2O_3	1.38
$MgCO_3$	10.00
$CaCO_3$	86.60
P_2O_5	.02
H_2O	.10
	99.00

OSSINING, WESTCHESTER COUNTY

The locality at Ossining has interest as affording structural marble for several buildings, including the State Hall at Albany. The quarries are situated in the yard of the State prison. The marble is a white or gray dolomite, rather crumbly in texture, and hence not well adapted for exterior work.

The Ossining Lime Co. has a flux and lime quarry south of the village near the railroad. The stone contains about 20 per cent magnesia, as shown by the following analysis:

SiO_2	.87
Al_2O_3	.57
Fe_2O_3	.25
MgO	19.95
CaO	31.40

WHITE PLAINS, WESTCHESTER COUNTY

A quarry about a mile north of White Plains and just west of the Harlem Railroad has been worked as a source of material for lime and crushed stone. It is known as the James O'Connell quarry. An analysis by Huntington gives the following components:[1]

SiO_2	2.08
Al_2O_3 / Fe_2O_3	.56
$MgCO_3$	37.79
$CaCO_3$	58.72
	99.15

PLEASANTVILLE, WESTCHESTER COUNTY

A white dolomitic marble that is found near Pleasantville has supplied considerable building material for New York City and the

[1] Eckel. "The Quarry Industry in Southeastern New York." 20th Report N. Y. State Geologist, 1902, p. 172.

Plate 34

A part of the mill of the South Dover Marble Company at Wingdale

towns along the Hudson river. There are several quarries, now abandoned, of which those formerly worked by the Snowflake Marble Co. have been the principal sources of architectural marble. The beds of the best quality measure about 100 feet thick and stand in vertical position; they are pure white, with very little foreign matter. The grain is extremely coarse, so that on a fractured surface the cleavage planes of the dolomite appear as large rhombic mirrorlike faces. A specimen in the State Museum collections has an average grain diameter of 8-10 mm. The texture is close and well knit, the dry stone absorbing only .15 per cent of water, according to Smock. The specific gravity is 2.87 and the weight 179 pounds to the cubic foot. Determinations of crushing strength by General Gilmore gave a maximum of 24,825 and a minimum of 18,750 pounds to the square inch from six tests. The following analyses illustrate the chemical composition of the marble:

	1	2	3
SiO_2	2.31	.10	.29
Al_2O_3	.40	.07	.....
Fe_2O_3	.25	.11	.....
$MgCO_3$	36.80	45.04	43.11
$CaCO_3$	59.84	54.12	54.80
Total	99.60	99.44	.....

Analysis no. 1 is by H. Ries;[1] no. 2 by C. F. Chandler;[2] and no. 3 by F. A. Wilber.[3]

The stone is too coarse for sawed or polished work. Its architectural quality may be observed in St Patrick's Cathedral (lower walls) in New York and the Methodist Episcopal Church in Ossining.

TUCKAHOE, WESTCHESTER COUNTY

A very active quarry industry was centered a few years ago at Tuckahoe. There are several openings in a narrow belt of dolomitic marble which extends in a north-northeast direction and is inclosed by Fordham gneiss on the west and the Manhattan schist on the east. The marble beds range from 40 or 50 feet to 100 feet or more in width. Their outcrop is marked by a surface depression between the ridges of harder rocks.

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[1] N. Y. State Museum Bul. 44, 1901, p. 832.
[2] U. S. Geol. Surv. 20th Annual Rep't, pt VI, 1899, p. 423.
[3] N. Y. State Museum Bul. 10, 1890, table facing p. 358.

One of the leading quarries for architectural stone is that last operated by the Waverly Marble Co., which suspended work in 1908, and previously operated in succession by Norcross Bros., A. T. Stewart and by A. Maxwell. It is an open pit 600 feet long, 150 feet wide, and 75 feet deep. A large part of the excavation afforded material suitable for architectural use, which may be seen in some of the large structures in New York, Boston and other cities. Among the more recent buildings that have been erected from the marble are those of the New York and Metropolitan Life Companies in New York. It is a coarse, brilliant white dolomite, very hard and almost devoid of silicate impurities except for occasional mica scales. The texture is very close; the grains have rhombic and irregular sections and range in diameter from 1 to 5 mm. It is thoroughly massive in appearance.

Since the quarries have been closed some marble has been shipped from the stock piles and the waste also has been employed in the manufacture of artificial stone. The Emerson-Norris Co. of New York has a plant at the quarries for making all kinds of artificial building stone, for which the white marble serves as the basis.

The Tuckahoe or Young's quarry lies in the center of the developed section. It is a cut 600 feet long and 100 feet in maximum width. The stone resembles the product from the Waverly quarry but is somewhat coarser. The quarry has furnished material lately for crushed stone for use in white concrete. The Kapailo Manufacturing Co. pumped out the workings in 1912 and have carried on work in a small way.

The Masterton or New York quarry lies on the south end and consists of two openings. It was very actively worked in the sixties and seventies of the last century. Of late years it has supplied material for making lime and marble dust. A polished sample in the State Museum collections shows a coarse, white dolomite with brownish inclusions of tremolite more or less completely altered to talc. The stone contains lime and magnesia in the proportions of true dolomite. Its specific gravity is 2.87, equivalent to 178 pounds to the cubic foot. The dry material, according to Smock, absorbs 0.14 per cent water. The following chemical analyses are based on the material of this quarry, but exemplify the general character of Tuckahoe marble.

	1	2	3
SiO_2	.24	..	..
Al_2O_3	.19	..	..
Fe_2O_3	.21	.21	..

MgO	21.25	20.71	20.77
$MgCO_3$	.....	.....	43.62
CaO	30.16		30.63
$CaCO_3$	.....	.....	54.69
CO_2	47.3	46.66	.....
Insol.	.....	1.33	.91
..	99.35	99.59	.....

Analysis no. 1 is by W. F. Hillebrand; no. 2 by P. deP. Ricketts; no. 3 by F. A. Wilber.

NONMETAMORPHIC MARBLES

Several kinds of unmetamorphosed limestones that occur in the State have been used for ornamental stones and may be included with the marbles for purposes of description.

GLENS FALLS

The Paleozoic limestones at Glens Falls, which are exposed in cliffs on both sides of the Hudson river, contain at their base a thick-bedded, fine-grained black limestone of Black River age. The layer is about 12 feet thick. The overlying limestones and shaly layers belong to the lowermost Trenton beds and are known as the Glens Falls limestone. The thicker and finer limestones are quarried for lime, building stone and other purposes, while the black layer yields also a good black marble. When polished, the latter shows a dense uniform black surface, scarcely distinguishable in appearance from the best of the imported black marbles. It is hard and very fine in grain. Large quantities were quarried and cut at one time, but the demand has fallen off in recent years. The stone was used largely for floor tiling, for which it was well adapted on account of its good wearing qualities and permanency of color. It has been made also into mantels, wainscoting, table tops and other interior decorative work. The principal shipper of late years has been Finch, Pruyn & Co. who use the materials also for lime and crushed stone. Smock states that the black marble has a specific gravity of 2.718 and weighs 169.4 pounds to the cubic foot. G. P. Merrill gives crushing tests on limestone from Glens Falls which may refer to the black layer, although not so stated. The strength on the bed was 11,475 pounds and on the edge 10,750 pounds to the square inch.

WILLSBORO POINT, ESSEX COUNTY

A fine black limestone is found in the Chazy beds which underlie the long neck of land that projects into Lake Champlain from the

Essex county shore. The beds contain from 16 to 18 feet of workable limestone, well adapted for building material, mostly of a gray or bluish gray color. Examples of the architectural use of the limestone are to be seen in the Reformed Church on Swan street, Albany, the eastern foundations and subbasement of the State Capitol, in the Brooklyn Bridge piers and other structures. The black layers were employed for ornamental work. A polished specimen in the collections of the State Museum shows that the stone is somewhat coarser than the Glens Falls material, with visible particles of crystalline calcite, but the color is rather a bluish black than a dense jet black. The quarries have not been worked in recent years.

PLATTSBURG

Quarries at Bluff Point, south of Plattsburg, supply an excellent "shell" marble which is found in the Chazy formation. The stone consists of fossil fragments, mostly rounded red and pink particles which have been derived from crinoid stems, with dark fragments of brachiopods in less abundance. The red particles measure from 2 to 5 mm in diameter. The fossils are inclosed in a gray groundmass that shows many glistening calcite cleavages, the texture being partly crystalline, thus approaching that of a true marble. As a consequence of this texture the stone takes a good polish, and the varicolored fossils lend an ornamental effect which is quite attractive. It has been sold as "Lepanto" marble, mainly for use in interior decoration. The quarries are now worked by the Vermont Marble Co. and the product is shipped to that company's works for cutting and polishing. In character the stone is a high-grade calcium limestone, containing 95 or 96 per cent calcium carbonate, about 3 per cent magnesium carbonate and 1 per cent or a little more of silica, alumina and iron oxides. The specific gravity is 2.71 and the weight 169 pounds to the cubic foot. Smock states that it absorbs 0.145 per cent of water.

CATSKILL AND HUDSON

The Becraft limestone in the Hudson valley contains beds of highly fossiliferous character, with a subcrystalline texture, that have been quarried to some extent for decorative material. The stone is gray in color, with round and crescentic fragments of crinoids replaced by white calcite. The quarries near the Hudson are now producing material for Portland cement, but the George Holdridge quarries at Catskill are worked for building and orna-

mental material according to demand. The stone contains upwards of 95 per cent of lime carbonate and is well adapted for building stone, lime, cement and furnace flux.

LOCKPORT

The lowermost layers of the Lockport dolomite are represented by a variegated red and gray material with fossil fragments 2 or 3 inches long. In polished condition it is quite attractive, but less even in texture than the Chazy marble. There has been no production of the stone for ornamental uses reported in recent years; a specimen in the State Museum collections from the quarries of D. J. Carpenter indicates a sound material well suited for building stone.

SERPENTINOUS MARBLES; VERDE ANTIQUE AND OPHICALCITE

The Grenville limestones of the Adirondacks not infrequently carry more or less serpentine, which results from the alteration of anhydrous magnesian silicates of the pyroxene and amphibole groups. With abundant, evenly distributed serpentine there results a mottled green and white stone that possesses an attractive appearance and that has been used for ornamental purposes. A description of these marbles has been given by G. P. Merrill.[1]

At Moriah and Port Henry, in Essex county, in this State, there has been quarried from time to time under the name of white marble, a peculiar granular stone consisting of an intricate mixture of serpentine, dolomite and calcite interspersed with small flakes of phlogopite. This stone, which is an altered dolomitic and pyroxenic limestone, seems mainly free from the numerous dry seams and joints that prove so objectionable in most serpentines, and can be obtained in sound blocks of fair size. The serpentinous portions are deep green in color, while the calcareous granules are faint blue, or whitish, affording a very pleasing contrast. Blocks being quarried at the time of my visit (1888) showed, however, a very even granular texture of nearly equal parts of serpentine, calcite and dolomite in grains of from one-eighth to one-fourth of an inch in diameter, forming an aggregate quite granitic in appearance at a slight distance. The stone polishes well, and is said to be durable. In the quarry bed, where the stone had been exposed for ages, it was noticed that the calcite had weathered out on the surface, leaving the serpentine protruding in small greenish knobs. The stone has been quoted in some of the older quarry price lists at $6 a cubic foot for the best monumental stock.

[1] Stone for Building and Decoration, 1897, p. 65.

The principal difficulty in the production of the stone for the market has been to secure an even quality, as the serpentine has a tendency to gather in bunches and stringers which look like the knots in granites.

Some of the larger occurrences of the serpentinous marble are in the vicinity of Port Henry, Essex county.

The J. E. Reed quarry is 6 miles due west of Port Henry, in the town of Moriah, near the precipitous hill known as Broughton ledge. The beds are exposed for a vertical distance of 25 feet and in blocks up to 5 feet thick. They show a rather uniform mixture of carbonates and serpentines, with here and there a band of pure serpentine from a few inches to several feet long. The bands are bent and

Fig. 18 Serpentinous marble, Reed quarry, Port Henry. Enlarged 10 times

twisted in a most complex way. A small fault cuts through the exposure and on the north side of it the stone is more broken. The limestone outcrops 200 feet east of the quarry site and also on the property of S. A. Foote, one-half of a mile farther east. The quarry was last worked about twenty years ago. The product was used for monuments, several of which are to be seen in the Port Henry cemetery, and to some extent for coping and lintels. When exposed long to the weather the serpentine particles are brought in relief through the more rapid solution of the carbonates. The stone is better adapted for interior decoration than outside work.

The Treadway quarry lies about a mile north of Port Henry on the brook which flows into Lake Champlain at Craig harbor. The opening shows 10 to 15 feet of the limestone.

Another quarry is north of the Cheever iron mine along the highway on property now owned by the Cheever Iron Ore Co. Two pits are to be seen on either side of the road, the one to the east exposing 15 feet of rock which shows many streaks of serpentine.

A quarry was once worked in the town of Thurman, Warren county. According to G. P. Merrill[1] the stone contains about equal parts of snow-white calcite and light yellowish-green serpentine in particles from one-sixteenth to one-fourth of an inch diameter. The texture is not very uniform.

Serpentinous limestones are found in numerous other localities in the Adirondack region, notably in the limestone areas in Essex, Warren and St Lawrence counties.

Serpentine unmixed with calcite is exposed over a large area on Staten Island. The rock lacks the translucency and rich color which are seen in the ornamental varieties, being usually dark green to nearly black, and stained by iron oxides. It carries black specks of chromite. The serpentine forms the central ridge of hills from St George on the north to a little beyond Richmond. On the borders the serpentine is mixed more or less with talc and tremolite, but in the interior contains little of the silicates, although there may be a few undecomposed remnants of pyroxene, olivine and amphibole which are the parent minerals of the serpentine. Originally the rock seems to have been a nonfeldspathic aggregate that most resembles the basic igneous types of the pyroxenite-peridotite group.[2] In most places it is badly fractured, being traversed by narrowly spaced joints and showing more or less differential movement along them, as a result probably of expansion of the mass in the alteration.

Serpentine also outcrops on Davenport's Neck at New Rochelle and near Rye, Westchester county.

An occurrence of serpentine in northern Essex county has been the source of much handsome material for museums, but has not been worked on a commercial scale. The serpentine occurs along the sides of a ravine just west of Port Douglas on the road to Keeseville. It is found only within the ravine, as above it is con-

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[1] *Op. cit.* p. 66.

[2] The derivation of the serpentine is discussed by the writer in School of Mines Quarterly, v. 22, 1901.

cealed by beds of Potsdam sandstone. The rock is a compact lustrous serpentine of light green color with scattered grains of black iron ore and flecks and clouds of the red oxide. The appearance is quite ornamental and such as to make the serpentine well adapted for polished work if sufficiently large pieces were obtainable. In the exposed section the rock is badly broken so that only blocks of small size can be secured, but it is quite likely that better material would be found deeper in the bank beyond the limits of frost action.

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The University of the State of New York

New York State Museum

JOHN M. CLARKE, Director

THE MINING AND QUARRY INDUSTRY OF NEW YORK STATE

REPORT OF OPERATIONS AND PRODUCTION DURING 1915

BY

D. H. NEWLAND

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The University of the State of New York
Department of Science, July 17, 1916

Dr John H. Finley
President of the University

Sir:

I beg to communicate to you herewith the manuscript of the *Mining and Quarry Industry of New York State: Report of Operations and Production During 1915,* prepared by David H. Newland, Assistant State Geologist, and to recommend its publication as a bulletin of the State Museum.

Very respectfully
JOHN M. CLARKE
Director

THE UNIVERSITY OF THE STATE OF NEW YORK
OFFICE OF THE PRESIDENT

Approved for publication this
24th day of July 1916

President of the University

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JOHN M. CLARKE, *Director*

THE MINING AND QUARRY INDUSTRY OF NEW YORK STATE

REPORT OF OPERATIONS AND PRODUCTION DURING 1915

BY

D. H. NEWLAND

INTRODUCTION

The mineral industries of the State, as represented by the branches engaged in mining and quarry operations, were not very prosperous during 1915. The conditions in certain restricted lines were fairly good and generally the tendency was toward improvement as the year advanced, but on the whole they did not conduce to activity and large outputs, as was the case in many allied lines of metallurgy and chemical manufacturing. The slump that developed out of the foreign situation still manifested an influence upon many of the industries.

The poorest showing of all was that made by the producers of structural materials — cement, stone and clay wares. There was a slackening in the demand for many of these materials, and prices consequently fell off sharply from competition among sellers for trade.

A feature of more than passing interest in the year's record of events was the inauguration of active ore shipments by the newly opened zinc mines at Edwards, St Lawrence county. The ore is included for the first time in the list of local mineral products. As yet there has been no extended development undertaken aside from

that by the Northern Ore Co., at Edwards, although there are many showings and prospects in the district which as now defined extends from Edwards to the vicinity of Sylvia lake.

From the summary of the year's reports rendered by the individual enterprises it appears that the value of the total production of ores and mineral materials amounted to $35,988,407. This represented a slight gain over the corresponding figure for 1914, which was reported as $35,870,004. The increase, however, was more apparent than real for it did not equal the actual increment arising from the entrance of new enterprises in the list of producers.

The products on which the valuations noted are based number over thirty, and with few exceptions represent the materials as they come from the mines and quarries without elaboration or manufacture, except so much as is necessary to put them in marketable form. They do not include secondary products like iron and steel, sulphuric acid, aluminum, carborundum, calcium carbide, artificial graphite, alkali products, etc., the manufacture of which constitutes a large industry by itself, with an annual output of a much greater value than that returned by the industries covered in this report.

Among the metallic minerals, iron ore ranks first in importance as regards value of output. The gross amount of ore hoisted from the mines last year was 1,365,064 long tons, which after allowance for shrinkage in concentration — practised by the Adirondack magnetite mines — left 944,403 long tons of shipping product valued at $2,970,526. In the preceding year the amount of ore hoisted was 1,122,221 long tons and the output of furnace ore and concentrates 751,716 long tons valued at $2,356,517. The market for iron ore improved rapidly during the year and there is every prospect of an active demand for the current season.

The clay-working industries are first in importance in regard to value of the annual production. Last year they returned an aggregate output valued at $10,002,373, compared with $9,475,219 in the preceding year. Most of the gain indicated was contributed by the potteries, whereas the manufacture of structural materials in most cases was smaller than in 1914. Another branch that reported a decline was the paving brick industry, which experienced a diminished demand for the material owing to temporary conditions.

Cement production was on a reduced scale, but this was partly accounted for by the shutdown of one of the larger mills for several months owing to a disastrous landslide. The market was

fairly active, but prices were so low as to afford little profit to makers. The output of portland cement amounted to 5,219,460 barrels valued at $4,175,528, against 5,667,728 barrels with a value of $5,088,677 in 1914. Natural cement did not vary much from the previous year's total, having been 223,564 barrels worth $134,138, against 232,076 barrels worth $115,117 in 1914.

There was a big decrease in stone products which was distributed among practically all branches of the quarry industry. The value of the entire output was $5,162,115 against $5,741,137 in the preceding year. The completion of some of the large engineering contracts on the canal and road systems of the State accounted in a measure for the decrease, although construction work in general was not so active as ordinarily. The granite quarries made the best showing and there is prospect of additional quarries being opened during the current year.

The salt mines and wells reported a record yield of 11,095,301 barrels, which exceeded the largest previous total — that for 1913 — by about 275,000 barrels. The value was reported as $3,011,932. In 1914 the output was 10,389,072 barrels valued at $2,835,706.

In the gypsum industry no material change took place and the output of 516,002 tons was practically the same as reported in the preceding year. The value of the products sold by the mining companies was $1,261,200 as compared with $1,247,404 in 1914.

The natural gas industry which had increased largely in recent years showed a considerable decline in the past season for which the flow amounted to 7,110,040,000 cubic feet against 8,714,681,000 cubic feet in 1914. The falling off was mainly in Erie county, where no new discoveries have been made recently that suffice to counterbalance the declining yield of the old wells. The value of the gas sold was $2,085,324, against a value of $2,570,165 reported for 1914. The oil wells of Allegany, Cattaraugus and Steuben counties contributed a total of 928,540 barrels as compared with 933,511 barrels in the preceding year. Prices showed an upward turn after a precipitate decline of over $1 a barrel, but the change was too late to show itself in the value which amounted to $1,476,378 against $1,773,671 in 1914.

Among the other branches of the mineral industry that shared in the activities were those of talc, graphite, garnet, pyrite, slate, mineral paints, mineral waters, emery, feldspar, quartz, molding and building sand, sand-lime brick, marl and zinc ore. One of the few of these that experienced an enlarged demand for its products

were the emery mines in Westchester county which reported an output of 3895 short tons against 763 short tons in 1914. The Adirondack garnet mines contributed 3900 short tons of that mineral as compared with 4026 tons in 1914. The talc mines were adversely affected by market conditions which are largely governed by the state of the paper trade. They contributed a total of 65,914 short tons, or a little less than in the preceding year.

Mineral production of New York in 1914

PRODUCT	UNIT OF MEASUREMENT	QUANTITY	VALUE
Portland cement	Barrels	5 667 728	$5 088 677
Natural cement	Barrels	232 076	115 117
Building brick	Thousands	943 241	4 703 295
Pottery			2 405 676
Other clay products			2 366 248
Crude clay	Short tons	7 109	12 424
Emery	Short tons	63	9 105
Feldspar and quartz	Short tons	23 751	117 390
Garnet	Short tons	4 026	134 940
Graphite	Pounds	2 483 339	151 143
Gypsum	Short tons	513 094	1 247 404
Iron ore	Long tons	751 716	2 356 517
Millstones			12 410
Metallic paint	Short tons	7 321	88 720
Slate pigment	Short tons	1 182	9 620
Mineral waters	Gallons	8 480 669	769 932
Natural gas	1000 cubic feet	8 714 681	2 570 165
Petroleum	Barrels	933 511	1 773 671
Pyrite	Long tons	61 513	266 930
Salt	Barrels	10 389 072	2 835 706
Sand and gravel			2 212 087
Sand-line brick	Thousands	17 696	111 326
Roofing slate	Squares	4 998	40 650
Granite			367 242
Limestone			3 316 063
Marble			230 242
Sandstone			1 056 990
Trap			770 600
Talc	Short tons	74 075	671 286
Other materials *a*			58 428
Total value			$35 870 004

a Includes apatite and marl.

Mineral production of New York in 1915

PRODUCT	UNIT OF MEASUREMENT	QUANTITY	VALUE
Portland cement	Barrels	5 219 460	$4 175 528
Natural cement	Barrels	223 564	134 138
Building brick	Thousands	951 329	5 040 306
Pottery	....	....	3 064 274
Other clay products	....	....	2 234 804
Crude clay	Short tons	13 745	28 684
Emery	Short tons	3 895	42 591
Feldspar and quartz	Short tons	22 196	93 152
Garnet	Short tons	3 900	134 064
Graphite	Pounds	2 500 000	162 000
Gypsum	Short tons	516 002	1 261 200
Iron ore	Long tons	944 403	2 970 526
Millstones	....	....	10 916
Metallic paint	Short tons	4 925	45 050
Slate pigment	Short tons	673	5 960
Mineral waters	Gallons	8 636 920	745 530
Natural gas	1000 cubic feet	7 110 040	2 085 324
Petroleum	Barrels	928 540	1 476 378
Pyrite	Long tons	57 241	265 362
Salt	Barrels	11 095 301	3 011 932
Building sand	Cubic yards	4 127 508	1 185 812
Molding sand	Short tons	454 511	415 073
Other sand *a*	....	....	1 065 133
Sand-lime brick	Thousands	18 226	115 912
Slate	Squares	....	45 000
Granite	....	....	422 597
Limestone	....	....	3 177 700
Marble	....	....	120 447
Sandstone	....	....	890 411
Trap	....	....	550 960
Talc	Short tons	65 914	576 643
Zinc ore	Short tons	....	*b*
Other materials *c*	....	....	435 000
Total value	....	....	$35 988 407

a Includes also gravel. *b* Reported under "Other materials." *c* Includes zinc ore, marl and apatite.

CEMENT

BY ROBERT W. JONES

At the beginning of 1915 there was little cement construction work in sight, and manufacturers in general began to cut their rate of production in order to reduce the accumulated stock held over from 1914.

The price of cement in the New York market, allowing for the refund on bags at the rate of 7½ cents a bag with four bags to the barrel, opened at $1.28 a barrel. This was a trifle lower than for the preceding year although the demand was about the same. In February the price dropped to $1.12, although for other sections of the United States it still held at the previous monthly average. During March there was a falling off in demand and prices in general were reduced, though the New York market price remained at the February level. An unfortunate disagreement between the producers of the Hudson River region and the Lehigh district occurred and cement sold in April on the New York market at 92 cents a barrel. This was only a local reduction, and nearby cities were not affected to as great an extent. In May a large amount of cement was sold for future delivery at 93 cents. During June, July and August the market continued at the same low level, with an average price of 92 cents. In September the price rose to $1.12, in October and November to $1.27 and the year closed at the high price of $1.32.

The production in New York State amounted to 5,219,460 barrels with a value of $4,175,528 as compared with 5,667,728 barrels and a value of $5,088,677 for 1914. This drop in production resulted chiefly from the temporary closing of one plant during the entire year and of two plants in the Hudson River region for several months.

There were seven plants in active operation during 1915. In August 1914, the Cayuga Lake Cement Corporation took over the plant of the Cayuga Lake Cement Company at Portland Point, Tompkins county, with the intention of enlarging the plant from a daily capacity of 800 barrels to 2000 barrels. This plant made no production during 1915. The Acme Cement Corporation began the active reconstruction of the plant formerly owned by the Seaboard Cement Company. This plant, which has never been operated, was

designed to produce cement by a dry method. Under the new management changes in methods of operation have been made and the production will be by wet method. Several attempts have been made on a small scale to produce cement with potash as a by-product. It is understood that during the present year construction work will be begun on a plant to be operated along this line.

During 1915 there was a decline in the output of natural cement although on account of the portland cement market conditions the price per barrel realized at the New York market was higher than for 1914. The output amounted to 223,564 barrels with a value of $134,138 as compared with 232,076 and a value of $115,117 for 1914. Nearly the entire output comes from the Rosendale region. There were three active plants in the State.

Production of cement in New York

YEAR	PORTLAND CEMENT		NATURAL CEMENT	
	Barrels	Value	Barrels	Value
1895	59 320	$278 810	3 939 727	$2 285 094
1896	260 787	443 175	4 181 918	2 423 891
1897	394 398	690 179	4 259 186	2 123 771
1898	554 358	970 126	4 157 917	2 065 658
1899	472 386	708 579	4 689 167	2 813 500
1900	465 832	582 290	3 409 085	2 045 451
1901	617 228	617 228	2 234 131	1 117 066
1902	1 156 807	1 521 553	3 577 340	2 135 036
1903	1 602 946	2 031 310	2 417 137	1 510 529
1904	1 377 302	1 245 778	1 881 630	1 207 883
1905	2 117 822	2 046 864	2 257 698	1 590 689
1906	2 423 374	2 766 488	1 691 565	1 184 211
1907	2 108 450	2 214 090	1 137 279	757 730
1908	1 988 874	1 813 622	623 588	441 136
1909	2 061 019	1 761 297	549 364	361 605
1910	3 364 255	2 939 818	292 760	147 202
1911	3 416 400	2 930 434	274 973	134 900
1912	4 495 842	3 488 931	287 693	142 165
1913	5 146 782	4 873 807	193 975	95 565
1914	5 667 728	5 088 677	232 076	115 117
1915	5 219 460	4 175 528	223 564	134 138

CLAY

BY ROBERT W. JONES

The year 1915 opened with building activities at a somewhat lower level compared with the corresponding period of the preceding year. This was the condition of affairs, particularly, in and near the city of New York. The smaller cities and villages of the State showed, in most cases, a decided improvement although not enough to bring the average materially above that for 1914. It was not until late summer that any decided upturn was noticed and then the monthly average was carried much higher than the corresponding months of 1914. Due to the greatly increased construction along certain industrial lines, there was a greater demand for electrical ceramic ware.

The following table gives the value of the output of clay materials in the State for the last three years:

Production of clay materials

MATERIAL	1913	1914	1915
Common brick	$5 938 922	$4 597 856	$4 886 734
Front brick	99 736	105 439	153 572
Paving brick	576 970	680 226	382 502
Hollow brick	44 265	38 119	59 683
Fireproofing	276 053	245 034	177 844
Terra cotta	1 113 322	892 630	647 815
Fire brick and stove lining	371 408	331 671	502 478
Drain tile	134 199	92 938	91 221
Sewer pipe	154 646	81 000	*a*
Pottery	3 367 187	2 405 676	3 064 274
Miscellaneous	1 164	4 630	36 250
Total	$12 077 872	$9 475 219	$10 002 373

a Included under miscellaneous.

One hundred sixty-five individuals or corporations reported a production of clay materials, as compared with 190 during 1914. This does not necessarily involve a like falling off in active yards and plants. During the past season there were, in the Hudson River district, several combinations of the larger yards under closer management. Labor troubles also caused a few yards to

close early in the season and a few for the same reason made no attempt to produce. There were during the year 79 idle plants situated in 27 counties. Common brick, front brick, common hollow brick, fire brick and stove lining and pottery showed gains over 1914.

The total number of building brick manufactured during the year was 951,329,000 with a value of $5,040,306 as compared with 943,-241,000 and a value of $4,703,295 for 1914. Of this number, 41,896,000 with a value of $290,003 were made by the wire-cut process. Paving brick fell from a production of 46,696,000 to 26,154,000 with a value of $680,226 and $382,502 respectively. Fireproofing fell from $245,034 to $177,844; terra cotta from $892,630 to $647,815; drain tile from $92,938 to $91,221. Even with this considerable falling off in some articles there was a total gain, over 1914, although still far below the production of 1913.

Thirty-four counties reported a production of clay products of which 29 had a production of common building brick. Eight counties reported a production of common hollow brick, 4 of front brick, 8 of drain tile, 4 of paving brick, 6 of fireproofing, 3 of terra cotta, 8 of pottery and 5 of fire-resisting forms.

The total value of clay products including miscellaneous wares but not including crude clay was $10,002,373 as compared with $9,475,219 for 1914. In value of products Onondaga county held first place with a total of $1,293,022 as compared with $1,556,093 for 1914. Ulster county was second with a production of $1,059,377 as compared with $895,126 for 1914. The production from Onondaga county consisted mainly of pottery with a value of $1,132,306, while that of Ulster county consisted entirely of common soft-mud building brick. Livingston county was third in value of production with $724,267. Counties reporting gains during the year were Albany, Cayuga, Columbia, Dutchess, Kings, Livingston, Niagara, Oneida, Ontario, Orange, Richmond, Saratoga. Schenectady, Ulster and Washington.

The following table gives the total value of clay products by counties for the last three years:

Production of clay materials by counties

COUNTY	1913	1914	1915
Albany	$473 325	$369 312	$447 344
Broome	*a*	*a*	*a*
Cattaraugus	275 763	334 557	180 290
Cayuga	5 800	8 765	9 800
Chautauqua	147 451	168 134	128 798
Chemung	*a*	*a*	*a*
Clinton	*a*	*a*	....
Columbia	307 571	198 866	271 672
Dutchess	634 043	430 269	491 156
Erie	1 000 055	819 427	710 101
Greene	290 116	196 889	130 093
Kings	539 002	449 839	489 264
Livingston	200 248	73 775	724 267
Monroe	278 145	168 463	98 863
Montgomery	*a*	*a*	*a*
Nassau	109 051	96 534	92 559
New York	*a*	....	....
Niagara	55 469	38 213	44 188
Oneida	84 714	45 000	159 400
Onondaga	1 613 395	1 556 093	1 293 022
Ontario	470 638	68 762	232 149
Orange	472 465	319 500	461 233
Queens	651 328	472 616	333 904
Rensselaer	151 202	124 152	233 332
Richmond	588 534	454 646	515 600
Rockland	820 475	747 026	446 583
St Lawrence	*a*	*a*	*a*
Saratoga	460 223	255 562	270 950
Schenectady	579 158	354 872	411 018
Steuben	*a*	*a*	*a*
Suffolk	81 000	69 300	66 600
Tompkins	....	*a*	*a*
Ulster	1 077 655	895 126	1 059 377
Warren	*a*	*a*	*a*
Washington	14 625	10 186	59 300
Wayne	*a*	....	....
Westchester	290 256	321 826	303 558
Other counties	406 165	427 509	337 952
Total	$12 077 872	$9 475 219	$10 002 373

a Included under other counties.

COMMON BUILDING BRICK

The building brick industry during 1915 was in a rather unsatisfactory condition. Labor troubles and price cutting in other building materials unsettled the conditions as to markets and selling price. In January the prices in the New York market at the opening ranged from $6 to $6.25 wholesale for the best grades.

A considerable amount of brick was sent to the New York market during the month of February. Building activities increased somewhat during this month and on March 1st the stock in storage, at New York, had been reduced to 3,150,000. Price cutting in other structural materials affected the selling price of brick and during March the majority of sales were at $5.75 wholesale for the best grades. In April there were 300,000,000 bricks in the Hudson river yards. This stock was reduced in May to 117,800,000 with no bricks in storage in New York. The wholesale price was advanced to $6.50 a thousand and remained at this rate until the middle of July when it fell to $5.75. With the end of the Haverstraw labor troubles, in the third week of August, the price advanced to $6 and at the end of the month had risen to $7. Over-anxiety to sell brought the price again to $6, which held to the middle of September. In October the price dropped to $5.875. At the end of October, the close of the brick-making season, there were only 60,000,000 bricks in the yards, or 50 per cent below normal. During November the price rose to $7. For the first time in many years the brick-making season, for a few of the larger yards, was carried through the winter months into the season of 1916.

Hudson River region. Labor troubles affected this region to such an extent during 1915 that several of the larger plants made hardly any attempt to operate until September. The following tables give the production of the Hudson River region for the last two years:

Output of common brick in the Hudson River region in 1914

COUNTY	NUMBER OF OPERATORS	OUTPUT	VALUE	PRICE PER THOUSAND
Albany	11	58 625 000	$301 512	$5 14
Columbia	5	44 705 000	198 866	4 45
Dutchess	14	91 580 000	430 269	4 69
Greene	5	25 604 000	123 475	4 82
Orange	6	75 500 000	319 500	4 23
Rensselaer	2	5 025 000	28 000	5 57
Rockland	25	150 183 000	747 026	4 30
Ulster	23	202 366 000	895 126	4 42
Westchester	7	56 289 000	302 656	5 37
Total	98	709 877 000	$3 346 430	$4 77

Output of common brick in the Hudson River region in 1915

COUNTY	NUMBER OF OPERATORS	OUTPUT	VALUE	PRICE PER THOUSAND
Albany	11	68 112 000	$392 344	$5 68
Columbia	4	57 766 000	271 672	4 70
Dutchess	14	108 459 000	491 156	4 62
Greene	5	27 555 000	130 093	4 70
Orange	6	84 997 000	461 233	5 42
Rensselaer [1]	1	....	....	....
Rockland	18	87 917 000	446 583	5 07
Ulster	21	211 230 000	1 059 377	5 01
Westchester	5	47 619 000	278 955	5 85
Total	85	693 655 000	$3 531 413	$5 09

[1] The output of Rensselaer county is included with that of Albany county.

The Hudson River region, which consists of three main productive areas with many isolated plants, has 127 plants available for the production of common soft-mud building brick. During the past season 73 per cent of these yards were operative during all or part of the season. Nine plants do not depend on the New York market for the disposal of their output. Of this number, one makes regular shipments into the New England markets and eight depend upon the local demand entirely.

The Haverstraw district with a rated machine capacity of about 2,950,000 a day made an output of 87,917,000 as compared with 150,183,000 for 1914. This loss was due chiefly to labor troubles, the result of an attempt to raise the working capacity of the machines to the same level as those of other Hudson river yards. Many yards, in the Haverstraw district, made no output until September, and the majority had only one or two machines in operation up to that date. The total value of the output was $446,583 as compared with $747,026 for 1914 with 56.25 per cent of the yards productive as compared with 78.12 per cent for the preceding year.

The Kingston district includes the yards at Port Ewen, East Kingston, Glasco, Saugerties and Malden, a total of 30, of which 21 made a production as compared with 22 during 1914. This is the second largest district of the Hudson River region and has an available machine capacity of 2,900,000 daily. The entire production of Ulster county in 1915 was made in the Kingston district.

The total output for the year was 211,230,000 with a value of \$1,059,000 as compared with 202,366,000 and a value of \$895,126 for 1914.

The Dutchess Junction district made an output of 101,484,000 with a value of \$448,306 as compared with 88,585,000 and a value of \$410,769 for 1914. The output of Dutchess county was 108,-459,000 with a value of \$491,156 as compared with 91,580,000 and a value of \$430,269 for 1914. The small output outside of Dutchess Junction, as reported from Dutchess county, is mainly produced by horse-power machines. Of the total number of yards in the Dutchess Junction district, 11 were productive as compared with 9 for 1914.

Outside of the three main districts there were thirty-two productive plants in the Hudson River region with a total production of 295,549,000 and a value of \$1,566,797 as compared with 260,-723,000 and a value of \$1,246,009 for 1914.

Long Island and Staten Island Region. The next district of importance during 1915 was that of Long Island and Staten Island with a total production of 63,224,000 having a value of \$330,004 as compared with 57,735,000 and a value of \$276,832 for 1914. The increase in this district was due mainly to the production made in Richmond county. As a result of comparative high selling price and short haul to the New York markets the larger yards of this county made a production throughout the winter months.

The entire product of this district consists of soft-mud building brick. There are at present six active plants using clays of Cretaceous and Quaternary age. Two inactive plants have pits opened in the Quaternary clays. There are three methods of mining in use in this district — pit, bench and scraping. The plants operating in the Quaternary clays use the pit method entirely, with hand labor and caving or making use of steam shovels. This clay is a dark brown to bright red tough material heavily overlain with gravel and sand. Owing to the great amount of gravel found with this clay it is necessary to go over it carefully by hand either in the pit or on a picking belt in order to remove the larger pieces of stone. It is passed through a set of rolls and then to rectangular tempering pits or direct to the machine. Where tempering pits are used the usual charge consists of about 108 cart-loads of clay to 9 cartloads of sand. Where it is not necessary to add tempering sand the clay is sent direct from the rolls to machines equipped with horizontal pug-mills. The yards operating in the Cretaceous clays have very little trouble with gravel and in

one case the material goes direct to a vertical machine without tempering. Other Cretaceous clays require the addition of as much as 20 per cent sand and then careful pugging before being used. The total machine capacity of the district is 409,500 a day for the active plants using nine machines. Five methods of drying are in use — open yard, pallet yard, hot-air car tunnels, steam-heated floors and steam car tunnels. The total drying capacity is divided as follows: open yard 45,000, pallet yard 1,251,150, steam tunnels 208,000, hot-air tunnels 90,720 and steam floor 33,000. The total number of arches of the active plants is 627 with capacities varying from 32,000 to 50,000 each. The inactive plants have 194 arches with capacities of 32,000 and 50,000 each.

Mechanicville region. This section reported a reproduction of 52,390,000 with a value of $261,950 as compared with 50,416,000 and a value of $240,912 for 1914. There are three active plants equipped with six machines having a combined daily capacity of 222,000. Two inactive plants have a daily capacity of 77,500 from three machines. The entire output of the active plants is dried in steam car tunnels. The burning capacity of the plants is about 435 arches. Almost the entire product of this section is disposed of in the New England states. The season is continuous, brick being produced during the entire year.

Erie county. This region reported an output of 28,807,000 with a value of $176,010 as compared with 40,015,000 and a value of $244,116 for 1914. Of this output 15,515,000 were made by the wire-cut process and had a value of $93,169. Due to the small quantity of clay available it is probable that the amount of soft-mud brick made in this section will continue to decrease while the product of the wire-cut machines will increase to a considerably greater amount. There are large quantities of shale and clay available for the manufacture of all grades of building and front brick in Erie county. Cheap fuel and nearby markets should greatly increase this output. There were during the season of 1915 six soft-mud plants and five wire-cut plants in active operation. The soft-mud brick are made under similar conditions as are found in the Hudson River region. There are a total of thirteen soft-mud machines with a combined daily available capacity of 275,000. Each machine, in this district, is usually operated with a daily capacity of 20,000. Three methods of tempering are in use — disintegrator with pug-mill, circular tempering pit and rectangular tempering pit. Four yards are equipped as pallet yards, one is a combined open and pallet yard and one is open. The permanent updraft kiln is in use in the majority of the plants, only one using

the ordinary form of scove kiln. Coal is used entirely for fuel. The wire-cut plants use shale or a combination of shale and clay, grinding the crude product in dry-pans, screening, storing in bins, forming with an augur machine, drying in direct-heat tunnels and burning in permanent rectangular downdraft kilns, continuous or semicontinuous kilns. The entire product is disposed of in the local markets.

The following table gives the output of common building brick by counties for the last two years.

Production of common building brick by counties

COUNTY	1914		1915	
	Number	Value	Number	Value
Albany	58 625 000	$301 512	68 112 000	$392 344
Cattaraugus	*a*	*a*	*a*	*a*
Cayuga	820 000	4 740	1 100 000	6 100
Chautauqua	3 740 000	34 726	3 905 000	31 187
Chemung	*a*	*a*	*a*	*a*
Clinton	*a*	*a*	....	....
Columbia	44 705 000	198 866	57 766 000	271 672
Dutchess	91 580 000	430 269	108 459 000	491 156
Erie	40 015 000	244 166	28 807 000	176 010
Greene	25 604 000	123 475	27 555 000	130 093
Livingston	*a*	*a*	*a*	*a*
Monroe	11 330 000	63 650	7 738 000	38 690
Montgomery	*a*	*a*	*a*	*a*
Nassau	15 352 000	88 300	13 783 000	86 747
Niagara	*a*	*a*	*a*	*a*
Oneida	6 450 000	43 000	22 200 000	154 200
Onondaga	21 800 000	147 250	22 635 000	155 376
Ontario	*a*	*a*	*a*	*a*
Orange	75 500 000	319 500	84 997 000	461 233
Rensselaer	5 025 000	28 000	*a*	*a*
Richmond	29 583 000	119 232	38 341 000	176 657
Rockland	150 183 000	747 026	87 917 000	446 583
St Lawrence	*a*	*a*	*a*	*a*
Saratoga	51 916 000	248 412	53 390 000	267 950
Steuben	*a*	*a*	*a*	*a*
Suffolk	12 800 000	69 300	11 100 000	66 600
Tompkins	*a*	*a*	*a*	*a*
Ulster	202 366 000	895 126	211 230 000	1 059 377
Warren	*a*	*a*	*a*	*a*
Washington	*a*	*a*	*a*	*a*
Westchester	56 289 000	302 656	47 619 000	278 955
Other counties	29 076 000	188 700	38 072 000	277 804
Total	932 759 000	$4 597 856	934 726 000	$4 886 734

a Included under other counties.

FRONT BRICK

There were five grades of front brick produced in the State during 1915 — smooth face red, rough face, dry-pressed red, dry-pressed manganese and wire-cut manganese. Owing to the few plants producing front brick it is not possible to give comparative figures of the different grades. There was a small amount of rough face vitrified front brick made as a by-product of the paving brick industry.

There is found along the Hudson river in certain localities a heavy bed of light brown laminated clay having a low fire shrinkage and comparatively high fusing point. This clay, without the addition of any other substance, burns to a dark red color and when formed in the augur machine gives a perfectly smooth surface. It is not necessary to add sand in tempering. With the present mining equipment and a small addition in the way of augur machines and kilns at a few of the present Hudson river yards there could be turned out an immense quantity of first-class smooth face red front brick for the New York market. At present this market depends entirely upon brick produced in Pennsylvania, Ohio and other western states.

The entire output of New York State during the last season amounted to 6,603,000 with a value of $153,572 as compared with 10,482,000 and a value of $105,439 for 1914.

COMMON HOLLOW BRICK

There were ten producers of common hollow brick during the last year with an output of 9,402,000 and a value of $59,683 as compared with 6,402,000 and a value of $38,119 for 1914. Nearly the entire output is made from soft, plastic clays and disposed of in the local markets.. Very little is made for the outside trade and the entire supply for the metropolitan market comes from other states.

It is not necessary to have, for this product, a very high grade of clay. Any plastic clay fairly free from sand and burning to a light brown at about 950° C. produces a good product. Such clays are found in great abundance throughout the Hudson River region and could be used, with a very small extra addition to the present equipment of the soft-mud yards, for the production of common hollow brick and other hollow ware of small size. It is not necessary to change the burning or drying equipment. They can be dried in pallet or open yards and burned perfectly in the ordinary form of scove kiln along with building brick.

FIREPROOFING

Fireproofing was produced to the value of $177,844 by seven companies as compared with $245,034 for 1914. There was no change in the number of producers. The output includes those articles known as hollow blocks and terra cotta lumber, exclusive of common hollow brick. Owing to the large size as compared with common hollow brick, there has been some difficulty in using the ordinary soft plastic clays of the State for the production of fireproofing. It is only those operators who have used a combination of clay and shale or grog that have been able to produce material which would compare favorably with that of the better known grades from other states. At present the production is only that necessary to supply the local demand.

PAVING BRICK

During the last season a considerable decrease took place in the production of paving brick not only in this State but throughout the United States. In general this was caused by a small demand. Many roads are being built of other materials, but with the intention of facing in the future with brick. This is especially true of the long trunk lines. In New York State financial troubles have been the main cause of the small production. Several plants have had to close temporarily on this account and one on account of a poor grade of crude material with high transportation costs. The total production for last year was 26,154,000 with a value of $382,502 as compared with 46,696,000 and a value of $680,226 for 1914. The following table gives the production in New York State during the last ten years:

Production of paving brick in New York

YEAR	QUANTITY	VALUE	VALUE A THOUSAND	NUMBER OF PLANTS
1906	11 472 000	$178 011	$15 51	5
1907	12 296 000	184 306	14 98	4
1908	14 570 000	211 289	14 50	5
1909	12 278 000	207 970	16 27	3
1910	19 762 000	333 511	16 88	4
1911	23 993 000	388 479	16 19	4
1912	18 249 000	382 984	15 78	5
1913	35 666 000	576 970	16 17	6
1914	46 696 000	680 226	14 56	6
1915	26 154 000	382 502	14 62	5

TERRA COTTA

The total production during 1915 had a value of $647,815 as compared with $892,630 for 1914. The material produced in this State is entirely from imported clays with the exception of a small amount for glaze. On this account it is hardly probable that the industry will have a very great growth as compared with other states. The building industry, making use of ornamental terra cotta, had a comparatively poor season and this has helped to a great extent in reducing the production in New York State.

DRAIN TILE

The output of drain tile had a value of $91,221 as compared with $92,938 for 1914. There were twelve active producers operating in Albany, Cayuga, Erie, Monroe, Onondaga, Ontario and Washington counties. With a few exceptions, the entire output is sold in the local markets. The local demand is far ahead of the production and a considerable quantity is imported from other states. There is a large and growing demand for a glazed drain tile as a substitute for the ordinary porous tile such as is made in this State. There is no reason why drain tile should not be produced to a greater extent in New York State as there is any amount of clays and shales which will produce either a porous, glazed or a nonporous unglazed tile. With the present water transportation there should be a great field among the southern agricultural coast states for a large output of drain tile. For the unglazed tile it would not be necessary to furnish much additional equipment to the present soft-mud brick plants in order to produce a large quantity. It would not be necessary to change either the drying or burning arrangement.

POTTERY

The production of pottery for 1915 in New York State had a considerable increase over the season of 1914. The output had a value of $3,064,274 as compared with $2,405,676 for the preceding year. The increase was due mainly to the greater demand for electric porcelain insulators and for American-made porcelains. The table below gives the value of products for the last three years.

Value of production of pottery

WARE	1913	1914	1915
Stoneware	$37 077	$28 888	$70 152
Red earthenware	35 790	31 806	34 031
Porcelain and semiporcelain	1 143 835	1 129 629	1 503 718
Electric and sanitary ware	2 100 985	1 187 506	1 440 373
Miscellaneous	49 500	27 840	16 000
Total	$3 367 187	$2 405 676	$3 064 274

CRUDE CLAY

The total value of crude clay produced during the season of 1915 amounted to $28,684. This was the value placed on 13,745 tons of which 11,012 tons were sold for slip clay. During the preceding season the entire output of slip and red burning clay amounted to 7109 tons with a value of $12,424. There was no production of white or buff burning clay during 1915.

Owing to the scarcity of aluminum sulphate for use in water filtration plants, there was some discussion locally of the utilization of the comparatively high alumina clays of the Hudson River region for the purpose of manufacturing this chemical. At the present time the greatest demand for slip clay comes from the electric porcelain manufacture. It is also used to a great extent as a bonding material in the manufacture of artificial abrasive wheels. In both the abrasive and slip uses it is necessary that the clay should have a quiet fusion and be free from bubbles when cooled. Such clays are found in this State at a few localities near Albany and Troy.

There are four known beds of clay in the Albany region which have furnished material suitable for slip and bonding purposes. The lowest has a thickness of about 8 feet and is fairly uniform in most exposures. At some localities this bed is of rather irregular deposition and composition. The result is that material of uncertain working qualities is sometimes produced. The next higher bed with a thickness of about 4 feet has furnished a great amount of fine slip but at present is not exposed so as to be available for production. It is from this bed that the early production was made. The third bed, which is the main producing one at present, has a thickness of about 14 feet and is very regular in composition and structure. Immediately above this is found a 2 foot bed of gray

sand. This sand layer causes considerable trouble, for without the exercise of much care it gets into the clay, and such mixed clay is unsuitable for slip. Above this sand layer comes the uppermost productive layer of slip, a 4 foot bed of very regular composition and which is in greater demand for electric insulator purposes than the next lower bed.

Onondaga county makes the only other production of crude clay. This material consists of a brown banded tough clay used chiefly in the manufacture of red ware.

FELDSPAR

No new quarries of feldspar were developed or worked in 1915, but there was an unusual manifestation of interest in the local feldspar resources by reason of the possibilities they offer for the production of potash.

It is well known that the extraction of potash from silicate minerals offers no special difficulties, so far as laboratory operations are concerned; fusion with some strong base like lime is all that is needed to release the alkalies from combination with the silica and bring them into soluble form. Though the feasibility of applying this process on a commercial scale has been discussed for a long time, no definite steps have been taken toward putting it in practice, and the matter still is in an experimental stage. The recent interest is the result of the curtailment of potash shipments, since practically all the supply of this very essential material is imported from Germany, which in normal times affords most of the requirements of the whole world.

The utilization of feldspar for the purpose has been investigated recently by Cushman and Hall [1] whose work has been given wide currency and has been the means of attracting much atention generally to the subject. Their method is based on the use of calcium chloride as flux. The feldspar is first pulverized and agglomerated with a little lime and then brought to fusion in a furnace with the aid of calcium chloride. By this treatment the alkalies are converted into chlorides which can then be leached from the fused mass with hot water. The solution will contain both potassium and sodium chlorides, the relative amounts varying of course with the proportions represented in the feldspar.

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[1] American Inst. Chem. Engineers, Philadelphia meeting, December 1914. The article is published in full in Metallurgical and Chemical Engineering, 13: 2, February 1915.

It is essential, of course, that the feldspar should have a high content in potash. Of the varieties which occur in nature only two fill this requirement; they are orthoclase and microcline, each having the same chemical composition — silica 64.7 per cent, alumina 18.4 per cent and potash 16.9 per cent. As a matter of fact, the theoretical percentage of potash as given is never attained, since there is always some soda present as a substitute. It is not uncommon, furthermore, to find the potash feldspar intergrown with albite or soda feldspar so as to reduce the amount of potash in the material very largely. In a quarry way, 10 to 12 per cent of potash is about the maximum that can be expected, and this only under the best conditions with the aid of more or less sorting and cobbing for the removal of waste.

It is the writer's experience that pegmatite bodies which will yield a uniform content of 10 per cent potash are extremely uncommon. Not only is the content likely to be reduced by admixture with other sorts of feldspar, but there is always a considerable percentage of quartz and iron silicates which has to be reckoned with, the amount varying with each locality and to a greater or lesser extent in different parts of the same body. Pegmatite is very prone to variation as can be seen in nearly every occurrence that is sufficiently well exposed to afford an estimate of its character. A pegmatite that will yield 75 per cent of potash spar quarrywise is exceptional, at least among the explored bodies of this State.

Pegmatites of such dimensions that they will afford the necessary quantity of material to justify the expense of establishing a works are not very abundant. An available supply of several million tons probably would be required, since the first cost of plants is high and the capacity must be large to afford the necessary margin of profit on the output. It is desirable also that the quarry should be convenient of access, with low freight rates on fuel, and with a supply of limestone nearby. Altogether the conditions are very definite and exclusive, much more difficult to meet than most writers on the subject seem to have realized.

The feldspar resources of New York have been recently investigated and described in detail.[1] Most of the local pegmatites that are of any considerable size are found among the crystalline schists, gneisses and acid igneous rocks of the Highlands and Adirondacks. They occur as dikes or tabular bodies which intersect the country rocks; the largest ones, however, have the form of bosses and

[1]The Quarry Materials of New York — Granite, Gneiss, Trap and Marble. N. Y. State Mus. Bul. 181, p. 154–75. 1916.

stocks, which as seen on the surface present rather irregular boundaries, though broadly considered have a more or less rounded outline, that is, nearly equidimensional. Such bodies may reach diameters of several hundred feet and of course extend for indefinite distances into the earth. Microcline is the variety of feldspar most common in the pegmatites of New York State.

In addition to feldspar, quartz and mica are sometimes produced from pegmatite quarries. The quartz, if pure, may find employment in pottery manufacture, or it is useful as an abrasive, for wood filler, and other purposes. Mica is obtained only in limited quantity from the local quarries.

Production. The production of feldspar, inclusive of unsorted pegmatite, in 1915 was 16,896 short tons, valued at $76,152. This was a decline from the output of the preceding year which was reported as 18,487 short tons, worth $97,192. Although the valuations in the two years seem to indicate a marked drop in prices, this was more apparent than real, since the statistics for 1915 included a larger proportion of the unsorted pegmatite than usual. Such material brings a low price, from $2 to $3 a ton. Selected crude spar of pottery grade is worth $4.50 to $5 a ton, ground spar for enamel and glass manufacture brings $7 to $8, and ground pottery spar from $8 to $10 a ton.

The quarries recently active are situated in Westchester, Essex and Saratoga counties. P. H. Kinkel's Sons and the Bedford Spar Co. operate quarries at Bedford, Westchester county. The Crown Point Spar Co. owns quarries and a mill at Crown Point and the Barrett Manufacturing Co. at Ticonderoga. The quarries near Batchellerville, Saratoga county, once worked by the Claspka Mining Co., but inactive for several years past, have been taken over by the Eureka Mining Co. and again placed in operation. The quarries afford a good grade of pottery material.

GARNET

The abrasive garnet industry experienced no marked changes last year, either as regards technology or its economic position. The Adirondack mines were worked on about the usual scale, though the production fell a little short of the total for the preceding year, amounting to 3900 short tons valued at $134,064. The value of the product was practically as large, however, owing to the increased proportion of high-grade crystal garnet in the total. For a number of years past the production has averaged around 4000 tons, and

only twice in recent years has it exceeded 5000 tons. Prices vary with the quality of the product, but the best crystal garnet which comes from the North River district holds steadily at $35 a ton.

The active producers in the Adirondack region last season included the North River Garnet Co. with mines on Thirteenth Lake, H. H. Barton & Son Co., operating on Gore mountain, and Warren County Garnet Mills at Riparius, all in Warren county. The property on Mount Bigelow, near Keeseville, in northern Essex county, recently worked by the American Garnet Company, was idle throughout the year. The resources of garnet in the Adirondack deposits are large and capable of yielding a much greater quantity than is now produced; it is no lack of capital or enterprise on the part of the mining companies that holds the production down to the present proportions, but the market is strictly limited and shows little tendency to growth.

Outside of the Adirondacks, garnet occurs in association with metamorphic rocks along the Appalachians from the New England states south to North Carolina and Alabama. The Highlands of southeastern New York belong to this mountain range, and in the vicinity of Peekskill, Westchester county, there are garnet deposits which have been worked in a small way. New Hampshire, Pennsylvania and North Carolina have yielded more or less of the mineral in recent years, but nowhere except in the Adirondacks has the mining industry attained any great importance.

The use of garnet as an abrasive has not made much headway in foreign countries. Spain is the only country of Europe which produces it in quantity and the output is sent to this country for manufacture. Spanish garnet is obtained from alluvial deposits which are found in the province of Almeria; it is of rather fine grain and only a partial substitute for the American product. The imports into the United States in 1915 were 1343 tons, with a declared value of $24,472; in 1914 they were reported as 1244 tons with a value of $20,277. There is no duty on the mineral and owing to the character of the Spanish deposits the foreign garnet can be shipped into this country at a cost well below that attainable by the domestic producers.

GRAPHITE

A production of flake or crystalline graphite was reported for last year as usual by the American mine at Graphite, Warren county. The output of this mine has long been the chief factor in the local industry, as in fact also it has represented a large share of the

product of refined crystalline graphite in the country. The property is worked by the Joseph Dixon Crucible Co. who convert the graphite into various commercial grades and products for the market. The mineral occurs as disseminated flakes in a hard quartzite, constituting only a few per cent of the rock mass, and its extraction and refining require special mechanical treatment, as well as much technical skill, to make the outcome successful from a market standpoint.

A new firm — the Graphite Products Corporation — was engaged last year in developing a property near Kings Station, 4 miles north of Saratoga Springs, on the easterly face of the ridge of crystalline rocks that defines the Adirondack boundary in this region. The property was worked in a small way by the Saratoga Graphite Co. during the years 1912 and 1913, but has since been idle. The latter company erected a small milling plant and made a little output of graphite from rock which was taken from outcropping ledges, of which there are several in the vicinity. The deposits were not sufficiently opened to permit work to be carried on advantageously. The present operations have been on a larger scale, with the view to thoroughly testing the deposits and the methods best adapted for milling the rock. It would appear from the exploratory work that the quartzite exists in beds of considerable thickness and extent which in general have a northeasterly strike parallel with the ridge and southeasterly dip. The first place where the rock shows in force is along the face of the ridge, just northwest of the old mill, where a quarry pit exposes 10 to 12 feet of quartzite, all of it graphitic, in thinly laminated and weathered condition. This pit is not now worked, but supplied much of the material in the earlier operations. The graphite is in finely divided scales, most of them less than 1 mm in diameter, and is mixed with a little brown mica. The outcrop is badly weathered and softened through oxidation of the contained pyrite which is rather plentiful in the unweathered rock. Higher up, near the summit of the ridge, a second outcrop of the graphitic rock was explored in the early operations by an open cut that reveals the quartzite in more massive beds, with a coarser flake. The beds dip to the southeast at a small angle. Along with the usual components, there is more or less pegmatitic material which forms knots and stringers in the quartzite, probably due to injection from a granite magma. The pit, as left by the operations of the first company, was 75 feet long and 30 feet wide. Between the two pits intervenes an area of hornblende gneiss which has the appearance of a metamorphosed gabbro. At present the main work

is being done at a point near the second pit but lower down close to a ravine which follows the slope of the ridge in a direction south of east. Tunnels have been driven along the course of the beds at points below the outcrop and the rock is mined underground so as to obtain fresh material, better adapted for mill treatment. The openings show fully 20 feet of rock fairly well charged with flake.

The quartzite here contains less mica than in the more easterly ledges and with the coarser size of the flake affords better material for mill treatment. From the available exposures it would appear that the graphite beds are found at two horizons, at least, within the quartzite, although the latter has been broken up by intrusions of the gabbro and by trap dikes so that the relations of the several outcrops are not readily apparent. Thin beds of crystalline limestone are intercalated in the quartzite, as can be seen in the bottom of the ravine by the old mill where serpentinous limestone forms the bed of the brook for some distance.

The upward trend of prices which has characterized the market for graphite during the past year or so has lent interest to the Adirondack deposits, although no other developments were started during 1915. Occurrences of graphitic quartzite are common in the eastern Adirondacks, and some may be found that appear to be both extensive and fairly rich in graphite as the quartzite of this region runs. Thorough tests are necessary, however, to show the value of any particular occurrence for mining purposes. Many failures have resulted in the business, due to lack of information about the character of the deposits that were to be worked or of the amenability of the material for extraction of the graphite.

GYPSUM

The gypsum industry was conducted on about the same scale as was reported for the preceding two or three years, and without any developments in the field that promise a change in the situation for the current season. The output of crude rock was 516,002 short tons, a few thousand tons more than in 1914 but still somewhat below the mark set in 1913 which was 532,884 short tons.

The market for gypsum products, especially calcined plasters, which had been rather depressed for some time owing to a condition of oversupply and of competition among the producers, showed a little improvement with an encouraging outlook for the immediate future. The production has grown very rapidly, the plaster industry being developed practically within the last decade, so that trade conditions have not become fully adjusted.

New York has a leading place in the gypsum industry, both from the standpoint of the mine product and of the manufacture of gypsum plasters. Its position in the calcined plaster trade is even more important than the output of rock gypsum would indicate, since in recent years large quantities of crude rock have been imported by local mills for calcination. Most of this material comes from the Maritime provinces of Canada, under the moderate transporation rates that ordinarily obtain for water shipments, and is used by calcining plants situated on the lower Hudson and in the environs of New York City. Nova Scotia is the source of most of the imported rock; it possesses large deposits that are conveniently situated for reaching the seaboard markets. In the interior of the State the calcining plants are mostly operated in connection with the local mines, from which they obtain all their crude material.

The production in 1915 was reported from four counties — Onondaga, Monroe, Genesee and Erie — the same that have yielded most of the supply in recent years. The deposits are not confined to these counties, however, since they outcrop at intervals all the way from Madison county on the east to the Niagara river, and extend southward under cover of rock for indefinite distances. The present mine localities possess advantages either as to quality of product or for economical extraction and marketing which have led to the concentration of operations in their vicinity.

The most easterly point at which beds of workable dimensions occur is in Madison county. Here they take the form of rather small lenses, not over 4 or 5 feet thick in most instances, though occasionally of greater thickness and extent, and consist of gypsum intermixed with argillaceous material and the carbonates of lime and magnesia. On the average the rock from this section carries about 70–75 per cent gypsum and is drab or gray in color. It has been employed quite extensively for agricultural plaster, and there are a number of quarries along the line of the Lehigh Valley Railroad to the south of Canastota, and also farther west along the Erie canal between Chittenango and Sullivan, which were worked quite extensively up to 15 or 20 years ago. Of late the substitution of limestone for gypsum in agriculture has restricted the market for the output of quarries of this section, and no active work has been under way for several years.

In Onondaga county around Fayetteville and Jamesville occur beds of large size up to 50 or 60 feet thick that are worked in a small way, mainly for agricultural plaster and for use in portland

cement. Some of the product in former years was converted into stucco; the rock is said to make a good strong plaster but rather dark in color, a feature that can be corrected to some extent by admixing with the lighter plasters of other districts. The gypsum occurs in several layers which vary somewhat in purity, color and grain. It is worked mainly by open-cut or quarry methods, operations being restricted to points where the overburden is relatively light.

The Union Springs district, Cayuga county, contains gypsum deposits of similar nature to those in Onondaga county and from 20 to 30 feet thick. They were worked very actively at one time for agricultural plaster, but in recent years have been operated intermittently and then only in a small way.

Gypsum beds appear in Seneca and Wayne counties, but no rock has been mined there in many years. In Ontario county, near Victor, is an old quarry which yielded a very fair quality of gypsum. Drill cores from the vicinity indicate the presence of two beds, of which the lower one is 6 feet thick and light in color. Mr C. L. Tuttle of Rochester intends to make additional explorations in this district during the current season.

Monroe county contains the well-known Wheatland district in which active mining has been carried on for many years. There are two layers, separated by a limestone bed 6 to 12 feet thick. The upper layer above is worked and is followed underground by means of tunnels and shafts. In the average, about 5½ feet of gypsum is excavated. Most of the output is calcined and used in wall plaster manufacture. Some is sold crude to cement mills and a small amount ground to land plaster. The active producers include the Lycoming Calcining Co. of Garbutt, the Empire Gypsum Co. of Garbutt and the Consolidated Wheatland Plaster Co. of Wheatland.

Near Oakfield, Genesee county, are the mines of the United States Gypsum Co. which are very extensive and productive and are based on a layer of white gypsum 4 to 5 feet thick. The output mainly is converted into stucco for wall plasters, hollow fireproofing and plaster-board, that are manufactured locally by the same company. West of these mines lies the property of the Niagara Gypsum Co., which also operate on a large scale, making various calcined products.

Just east of Akron, Erie county, are the mines of the American Gypsum Co. and the Akron Gypsum Products Corporation. They

supply rock of lighter colors, suitable for the manufacture of calcined plasters, but only the latter company engage in their manufacture. The American Gypsum Co. sells its output in crude form mainly to cement mills. The plan and mines of the Akron Gypsum Products Corporation were taken over in 1915 by the American Cement Plaster Co. The continuation of the gypsum deposits is found to the west of Akron, as shown by explorations with the drill made a few years ago. There are records of the occurrence of white gypsum under the city of Buffalo, but owing to the large flow of water that is encountered in the beds there has been no attempt put forth to develop the deposits.

The production of gypsum for 1914 and 1915 is shown in the accompanying table, which also gives the several forms in which it was sold by the mining companies. Considerably more than one-half is converted into calcined plasters by the latter. A few thousand tons are ground for land plaster, and the remaining is sold crude to portland cement works or to calcining mills outside of the district. There is some fluctuation from year to year in the relative proportions of mined product and the amount of calcined plasters, as the mining companies often hold considerable amounts of rock in stock. The production of calcined plasters from foreign rock is not included in the statistics.

Production of gypsum in New York

MATERIAL	1914		1915	
	Short tons	Value	Short tons	Value
Total output, crude	513 094	....	516 002	....
Sold crude	169 257	$246 804	162 686	$241 511
Ground for land plaster	7 096	15 342	6 536	13 486
Wall plaster, etc., made	297 084	985 258	292 344	1 006 203
Total	....	$1 247 404	....	$1 261 200

IRON ORE

The iron mining industry reversed its course last year and showed a marked improvement in activity as compared with the record for 1914. The latter year was a period of great depression for the

eastern mines, with demand and prices on a lower basis than they had been for a long time. The output consequently fell off, the mines reporting the smallest total that had been recorded since the panic times of 1907-8. While the upturn that came in the spring of 1915 was registered in the trend of production for the year, it did not show itself fully in the statistics, inasmuch as the mining companies were not in position to take advantage immediately of the change.

The outlook for the immediate future of the iron industry in the State is encouraging. The curtailment of the shipments of foreign ores, due to the high ocean freights and uncertainties incident to the European War, has created a situation favorable to the local mines whose market is found in the metallurgical centers of New York and eastern Pennsylvania. A further advantage has been the general rise in railroad rates which has created a larger margin between the rates for Lake Superior ores and those from the East.

The production of furnace ores and concentrates, as reported by the different mines that were operative in the State, was 944,430 long tons. In comparison with the total reported for the preceding year, this represented an increase of 192,714 tons or about 25 per cent, but still was smaller than any other year previously since 1908. The value of the product at the mines was $2,970,526, or $3.15 a ton, against an average of $3.13 a ton in 1914.

The total was made up of magnetite, hematite and limonite in the order of their importance. The magnetite mines in the Adirondacks and the Highlands of Orange county contributed altogether 873,422 long tons worth $2,825,176, against 703,670 long tons worth $2,251,656 in 1914. The hematite was from the Clinton belt in Oneida and Wayne counties. The limonite, which amounted to a few hundred tons only, came from Columbia county.

Production of iron ore in New York State

YEAR	MAGNETITE	HEMATITE	LIMONITE	CARBONATE	TOTAL	TOTAL VALUE	VALUE A TON
	Long tons	Long tons	Long tons	Long tons	Long tons		
1895	260 139	6 769	26 462	13 886	307 256	$598 313	$1 95
1896	346 015	10 789	12 288	16 385	385 477	780 932	2 03
1897	296 722	7 664	20 059	11 280	335 725	642 838	1 91
1898	155 551	6 400	14 000	4 000	179 951	350 999	1 95
1899	344 159	45 503	31 975	22 153	443 790	1 241 985	2 80
1900	345 714	44 467	44 891	6 413	441 485	1 103 817	2 50
1901	329 467	66 389	23 362	1 000	420 218	1 006 231	2 39
1902	451 570	91 075	12 676	Nil	555 321	1 362 987	2 45
1903	451 481	83 820	5 159	Nil	540 460	1 209 899	2 24
1904	559 575	54 128	5 000	Nil	619 103	1 328 894	2 15
1905	739 736	79 313	8 000	Nil	827 049	2 576 123	3 11
1906	717 365	187 002	1 000	Nil	905 367	3 393 609	3 75
1907	853 579	164 434	Nil	Nil	1 018 013	3 750 493	3 68
1908	663 648	33 825	Nil	Nil	697 473	2 098 247	3 01
1909	934 274	56 734	Nil	Nil	991 008	3 179 358	3 21
1910	1 075 026	79 206	4 835	Nil	1 159 067	3 906 478	3 37
1911	909 359	38 005	5 000	Nil	952 364	3 184 057	3 34
1912	954 320	103 382	Nil	Nil	1 057 702	3 349 095	3 17
1913	1 097 208	120 691	Nil	Nil	1 217 899	3 870 841	3 18
1914	703 670	47 705	341	Nil	751 716	2 356 517	3 13
1915	873 422	70 147	834	Nil	944 403	2 970 526	3 15

Most of the magnetite shipments consisted of concentrates, which averaged around 65 per cent iron. Lump magnetite was supplied by the mines of Orange county and the two Mineville companies, the average of this material being about 60 per cent iron. In the concentration of magnetite, as practised in the Adirondacks, each ton of finished product represents from a little over 1 to nearly 3 tons of crude ore, the ratio varying with the different deposits. The gross output of magnetite, as hoisted from the mines, was 1,294,056 long tons. The total ore hoisted from all mines was 1,365,064 tons.

The list of active mining companies for the year included the following in the Adirondack region: Witherbee, Sherman & Co., and Port Henry Iron Ore Co., Mineville; Chateaugay Ore & Iron Co., Lyon Mountain. The Cheever Iron Ore Co., Port Henry, and the Benson Mines Co., Benson Mines, were inactive during the year, although they contributed to the output of the preceding year. In southeastern New York the producers were the Hudson Iron Co.,

Fort Montgomery, and Sterling Iron and Railway Co., Lakeville. The hematite mines were operated by C. H. Borst, Clinton; Furnaceville Iron Co., Ontario Center, and Ontario Iron Co., Ontario Center. The single limonite mine was worked by Barnum, Richardson & Co., who shipped the output to their furnaces at Salisbury, Conn.

Mineville. A revival of activity was reported by the two companies who are engaged in mining at this place. Witherbee, Sherman & Co. continued work in the Old Bed group, where the main operations in the past have been centered and also operated the Harmony and Barton Hill mines. The Barton Hill property, which was recently reopened, has become one of the principal sources of ore supply, the new development uncovering some extensive deposits of milling ore of desirable quality. This ore is the lowest in phosphorus of the Mineville magnetites and has been much in demand during the past year.

The concentrates are used in part in the Port Henry furnace which has been running of late on low phosphorus pig. Besides the properties in Mineville, the company owns a series of deposits which extend for some distance north of these and which include the Smith and the Sherman mines, both equipped for production.

Lyon Mountain. Important improvements have been made in the mining installation of the Chateaugay Ore & Iron Co., which works the magnetite deposits at this place. The principal feature of the improvements is the construction of a new shaft which is designed to provide a hoisting capacity of 3000 tons a day and will take the place of the several small shafts at irregular intervals along the outcrop which hitherto have been in use. The shaft has been extended to about 900 feet depth and levels are now being opened from it; during the past year it has provided some ore for milling, but only such as was taken out in the course of development. With the completion of this important work, the methods of underground mining will be changed so as to effect important economies as well as to increase the production. The next step to be undertaken is the construction of a new mill which is required if the milling capacity is adjusted to the mine output. The company has plans for such a mill under consideration. All the ore is crushed and concentrated before shipment. The concentrates, which carry above 60 per cent of iron, are very low in phosphorus; consequently they are in great demand. They are smelted in the furnaces at Standish and Port Henry.

Benson Mines. No shipments were made from this place last year. Changes in the methods of concentration are to be effected before the mines are again placed in operation.

MILLSTONES

Millstones are quarried from the Shawangunk grit of Ulster county, one of the few sources of these materials in the United States. The industry was established there many years ago, and during the earliest period of its history was in a flourishing state as the product found a wide sale for the grinding of cereals. This market has been greatly curtailed within the last quarter of a century or more by the general use of the roller mill process for making flour, although some mills still make use of stones for grinding the coarse grains. The small corn mills in the South furnish one of the larger markets for the New York product. Besides millstones, the Ulster county quarries also turn out disks of stone known as chasers which are employed in a roll type of crusher, the disks revolving on a horizontal axis in a circular pan that is sometimes floored by blocks of the same stone. This type of crusher is much used in the grinding of minerals like quartz, barytes and feldspar, and paint materials.

The Shawangunk grit of which the stones are made outcrops on Shawangunk mountain, a monoclinal ridge that extends from Rosendale southwesterly into New Jersey and Pennsylvania. The grit forms the top of the ridge, dipping to the west in conformity with the slope of the surface, and in the Wallkill valley along the north side disappears below shales and limestones which belong to the uppermost formations of the Siluric. The grit rests unconformably upon the Hudson River series. In thickness it ranges from 50 to 200 feet. The millstones are quarried within a limited section of the ridge, between High Falls on the north and Kerhonkson on the south, where the grit appears to be best adapted to the purpose. In character it is a light gray conglomerate with pebbles of milky quartz ranging in size from that of a pea to 2 inches in diameter. The pebbles are rounded and firmly cemented by a silicious matrix of gritty texture.

The work of quarrying requires only a small equipment, the stone being pried out by hand bars, after the use perhaps of a drill and plugs and feathers. Sometimes a little powder may be employed, but care has to be exercised in its use to avoid weakening the stone. The spacing of the natural joints determines the size of the stone

that may be produced, the joints occurring in two sets approximately parallel to the dip and strike of the formation. The rough blocks thus obtained are reduced to shape by the hammer and point and then undergo a final tool dressing which varies with the use to which the stone is to be put. The hole or " eye " in the center is drilled by hand.

The sizes of the stone marketed ranges from 15 to 90 inches in diameter. The greater demand is for the smaller and medium sizes with diameters of 24, 30, 36, 42 and 48 inches. The chasers are supplied in sizes that usually run from 48 to 90 inches and with widths up to 24 inches. The prices range from $3 for an 18-inch stone to $75 or $100 for the largest sizes.

The production at one time was valued at over $100,000 a year, but within the last decade it has averaged less than $20,000. During 1915 the total sales of millstones and chasers were reported as $10,916 as compared with $12,410, the value of the stones marketed in 1914.

MINERAL PAINT

For the purposes of the present report only the natural mineral pigments are included under this title. In addition to these materials, there is a production in the State of artificial pigments, especially those of lead, but as the substance used in their manufacture is derived from outside sources, they have not been included among the local products.

The crude paint materials that occur within the State include iron ore, ocher, shale and slate. Of the iron ores, the Clinton hematite affords an excellent base for the manufacture of metallic paint and mortar color of red to brownish red colors. The beds with a relatively high iron content are employed, as they possess the softness and uniformity of texture, as well as depth of color which are requisite for such use. The ore is obtained from the mines at Clinton, Oneida county, owned by C. A. Borst, and from those at Ontario, Wayne county, worked by the Furnaceville Iron Co. The hematite from the former locality is of oolitic nature and carries about 45 per cent iron. The ore from Ontario contains about 40 per cent iron and is known as " fossil " ore. In years past the red hematite from the northern part of the State has also been employed, but recently this ore has not been obtainable.

Both shale and slate from the local formations have been used rather extensively for pigments. They occur in various colors depending upon the amount and nature of the iron oxides present.

A large percentage of ferric oxide lends a reddish color which resembles that of metallic paint. Red shale has been obtained from the base of the Salina beds near Herkimer. The red slate from Washington county is another material that has been rather extensively ground for pigment. At Randolph, Cattaraugus county, beds of green, brown and bluish shale occur in the Chemung formations and have been utilized in the past.

Deposits of ferruginous clay, or ocher, are found in many places within the State, but they are not now worked. Sienna, a dark brown variety of ocher, is found near Whitehall where it was produced a few years ago.

MINERAL WATERS

New York has held for a long time a leading position among the states in the utilization of mineral waters. The different springs, of which over two hundred have been listed as productive at one time or another, yield a great variety of waters in respect to the character and amount of their dissolved solids. There are some that contain relatively large amounts of mineral ingredients and are specially valuable for medicinal purposes; Saratoga Springs, Ballston Springs, Richfield Springs, Sharon Springs and Lebanon Springs are among the more noted localities for such waters. Numerous other springs are more particularly adapted for table use, containing only sufficient mineral matter to give them a pleasant saline taste. Both kinds of waters are generally carbonated and sold in small bottles.

Of late there has developed an important business in the sale of spring waters which can hardly be classed as mineral in the common acceptance of the word, but which are extensively consumed for office and family use in the larger towns and cities. Their employment depends upon their freedom from harmful impurities, in which feature they are generally superior to the local supplies. In so far as such waters are an article of commerce they may well be included in a canvass of the mineral water industry. They are usually distributed in large bottles or carboys in noncarbonated condition.

Character of mineral waters. Among the spring waters that contain mineral ingredients in appreciable quantity, those characterized by the presence of alkalis and alkaline earths are the most abundant in the State. The dissolved bases may exist in association with chlorin and carbon dioxid, as in the springs of Saratoga

county, or they may be associated chiefly with sulphuric acid, as illustrated by the Sharon and Clifton springs.

The mineral waters of Saratoga Springs and Ballston are found along fractured zones in Lower Siluric strata, the reservoirs occurring usually in the Trenton limestone. They are accompanied by free carbon dioxid which, together with chlorin, sodium, potassium, calcium and magnesium, also exists in dissolved condition. The amount of solid constituents in the different waters varies from less than 100 to over 500 grains a bottle. Large quantities of table and medicinal waters are bottled at the springs for shipment to all parts of the country. The carbon dioxid which issues from the wells at Saratoga at one time was an important article of commerce, but its sale has been discontinued.

The waters at Richfield Springs contain the elements of the alkali and alkaline earth groups together with sulphuric acid and smaller amounts of chlorin, carbon dioxid and sulphureted hydrogen. They are employed for medicinal baths as well as for drinking purposes. The springs issue along the contact of Siluric limestone and Devonic shales. Sharon Springs is situated to the east of Richfield Springs and near the contact of the Lower and Upper Siluric. Clifton Springs, Ontario county, and Massena Springs, St Lawrence county, are among the localities where sulphureted waters occur and are utilized.

The Oak Orchard springs in the town of Byron, Genesee county, are noteworthy for their acid waters which contain a considerable proportion of aluminum, iron, calcium and magnesium, besides free sulphuric acid.

The Lebanon spring, Columbia county, is the single representative in the State of the class of thermal springs. It has a temperature of 75° F. and is slightly charged with carbon dioxid and nitrogen.

Ordinary spring waters. The greater quantity of spring waters consumed in the State belongs to the nonmedicinal, noncarbonated class, represented by such springs as the Great Bear, Deep Rock, Mount View, Sun Ray, Chemung etc. The waters are obtained either by flowing springs or from artesian wells and are shipped in carboys or in tank cars to the principal cities where they are bottled and distributed by wagons among the consumers. The essential feature of such waters is their freedom from noxious impurities. This is generally safeguarded by the care exercised in the handling of the waters which are also regularly examined in the chemical and bacteriological laboratories.

List of springs. The following list includes the names and localities of most of the springs in the State that are employed commercially, as shown by a canvass of the industry:

NAME	LOCALITY
Baldwin Mineral Spring	Cayuga, Cayuga county
Coyle & Caywood (Arrowhead Spring)	Weedsport, Cayuga county
Diamond Rock Spring	Cherry Creek, Chautauqua county
Breesport Oxygenated Spring	Breesport, Chemung county
Breesport Deep Rock Water Co	Breesport, Chemung county
Chemung Spring Water Co	Chemung, Chemung county
Keeseville Mineral Spring	Keeseville, Clinton county
Lebanon Mineral Spring	Lebanon, Columbia county
Arlington Spring	Arlington, Dutchess county
Mount Beacon Spring	Mount Beacon, Dutchess county
Mount View Spring	Poughkeepsie, Dutchess county
Monarch Spring Water Co	Beacon, Dutchess county
Elk Spring Water Co	Lancaster, Erie county
Mohawk Spring	Amsterdam, Montgomery county
Clinton Lithia Springs, Inc	Franklin Springs, Oneida county
Glen Alix Spring	Washington Mills, Oneida county
Lithia Polaris Spring	Boonville, Oneida county
F. H. Suppe (Franklin Lithia Spring)	Franklin Springs, Oneida county
Orville Risley	New York Mills, Oneida county
Geneva Mineral Water Springs	Geneva, Ontario county
Crystal Spring	Oswego, Oswego county
Deep Rock Spring	Oswego, Oswego county
Great Bear Spring	Fulton, Oswego county
White Sulphur Spring	Richfield Springs, Otsego county
Black Rock Spring	Rensselaer, Rensselaer county
Mammoth Spring	North Greenbush, Rensselaer county
Shell Rock Spring	East Greenbush, Rensselaer county
Madrid Indian Spring	Madrid, St Lawrence county
Artesian Lithia Spring	Ballston Spa, Saratoga county
Comstock Mineral Spring	Ballston Spa, Saratoga county
Mohican Spring	Ballston Spa, Saratoga county
Arondack Spring	Saratoga Springs, Saratoga county
Hathorn (Nos. 1 and 2) Springs	Saratoga Springs, Saratoga county
Coesa Spring	Saratoga Springs, Saratoga county
Geyser Spring	Saratoga Springs, Saratoga county
Minnonebe Spring	Saratoga Springs, Saratoga county
Orenda Spring	Saratoga Springs, Saratoga county
Saratoga Gurn Spring	Saratoga Springs, Saratoga county
Saratoga Vichy Spring	Saratoga Springs, Saratoga county
Chalybeate Spring	Sharon Springs, Schoharie county
Eye Water Spring	Sharon Springs, Schoharie county
Sulphur-Magnesia Spring	Sharon Springs, Schoharie county
White Sulphur Spring	Sharon Springs, Schoharie county
Red Jacket Spring	Seneca Falls, Seneca county

NAME	LOCALITY
Setauket Spring	Setauket, Suffolk county
Elixir Spring	Clintondale, Ulster county
Sun Ray Spring	Ellenville, Ulster county
Vita Spring	Fort Edward, Washington county
Vermont Mineral Spring	Granville, Washington county
Briarcliff Lodge Association	Briarcliff Manor, Westchester county
Gramatan Spring Water Co	Bronxville, Westchester county
Orchard Spring	Yorktown Heights, Westchester county

Production. The returns received from the spring water companies for 1915 showed total sales of 8,636,920 gallons with a value of $745,530, which was about the usual quantity. The largest business was reported by Oswego county, which, however, was restricted to the sale of fresh spring waters for family and office supply. Saratoga county led in the output of carbonated and medicinal waters.

NATURAL GAS

Returns received from the producers and distributors of natural gas within local territory show a further drop in the yield for 1915. The continuation of the decline over a period of two years, as has been the case, seems to indicate a serious situation with respect to supplies which are not maintaining equilibrium with the drain resulting from exploitation. This is to be attributed no doubt to the smaller flow obtained from new wells than in the few previous years when some very productive pools were tapped in the western counties. There has been no material enlargement of the productive area since the bringing in of the large wells at Orchard Park, Erie county, in 1912, which reflected itself so markedly in the returns for 1913.

The flow of natural gas in 1915, according to the reports of producers and distributors, was 7,110,040,000 cubic feet, as compared with 8,714,681,000 cubic feet in 1914 and 9,055,429,000 cubic feet in 1913, which is the high mark for the industry. The figures represented a decline of about 18 per cent during the year and of over 20 per cent in the two years including 1913. The loss is traceable mostly to the pools in Erie county, whereas the other counties of importance, like Genesee, Chautauqua, Allegany and Cattaraugus, held their own or showed a very small decrease for the year.

In value, the production last year was reported as $2,085,324 against $2,570,165 in 1914. The value is based on the average

prices received for the gas in the different centers of consumption. The mean for the whole State was 29.4 cents a thousand in both years. The actual prices range from 20 cents to over 50 cents a thousand, the latter being reported from the isolated fields in the central counties.

Production of natural gas

YEAR	OUTPUT 1000 CU. FT.	VALUE	NUMBER OF WELLS
1904	2 399 987	$552 197	....
1905	2 639 130	607 000	....
1906	3 007 086	766 579	....
1907	3 052 145	800 014	925
1908	3 860 000	987 775	1 100
1909	3 825 215	1 045 693	1 280
1910	4 815 643	1 411 699	1 340
1911	5 127 571	1 547 077	1 403
1912	6 564 659	1 882 297	1 660
1913	9 055 429	2 549 227	1 750
1914	8 714 681	2 570 165	1 797
1915	7 110 040	2 085 324	2 051

It would be of interest to give the statistics according to counties or districts represented in the production, but owing to the fact that the larger distributing companies may take their supplies from several fields it has become difficult to segregate the output in this way, although the figures for a few of the counties can be stated separately. In all about 200 individuals and firms are represented in the industry. Chautauqua county alone has over 100 producers, but most of them are small with only a single well each, used for family supply. The production of this county in 1915 was 1,210,378,000 cubic feet valued at $335,610. Erie has the largest output but the exact figures can not be stated. The four counties of Allegany, Cattaraugus, Erie and Genesee, which are tributary to Buffalo, contributed a total of 5,580,928,000 cubic feet with a value of $1,631,194. This represented a large decline from the total reported for the preceding year, as the result of the falling off in Erie county. Genesee county increased its flow somewhat and Allegany and Cattaraugus counties contributed about the usual amount. The statistics do not include gas used in the pumping of oil wells in the Allegany-Cattaraugus field. Among other counties, Ontario contributed a total of 158,301,000 cubic feet valued at

$53,801. The remaining counties represented in the industry were Livingston, Monroe, Niagara, Onondaga, Oswego, Schuyler, Steuben, Wyoming and Yates.

The business of distributing the output among the cities and communities within the different districts is controlled by a relatively few companies, some of whom are employed also in productive operations. The largest single distributor is the Iroquois Natural Gas Co. of Buffalo with pipe lines to the principal fields in Allegany, Cattaraugus, Erie and Genesee counties. The Alden-Batavia Natural Gas Co. and the Pavilion Natural Gas Co. are important producers and distributors in the Erie-Genesee county district. In Chautauqua county the larger operators are the Frost Gas Co. and the Silver Creek Gas & Improvement Co. In Allegany and Cattaraugus counties the Gowanda Natural Gas Co., the Empire Gas & Fuel Co. and the Producers Gas Co. have pipe lines. In Ontario county the main producer and distributor is the Ontario Gas Co. Among the smaller companies engaged in the business are the Consumers Natural Gas Co. with wells in the town of Darien, Schuyler county, the Baldwinsville Light & Heat Co. of Baldwinsville, Onondaga county, the Pulaski Gas & Oil Co. of Pulaski, Oswego county, and the Sandy Creek Oil & Gas Co. of Sandy Creek, Oswego county.

The geological occurrence of natural gas in the State has been described in various reports issued by the New York State Museum. The productive gas pools are distributed over portions of sixteen counties, but they are all in the section that lies west of the 76th meridian, which crosses the west end of Oneida lake. Discoveries have been reported from time to time in the eastern part of the State, notably in the sections along the Mohawk river as far east as Albany county; in this region, however, the gas seems to be confined to small pockets which are rapidly depleted.

The most prolific gas pools thus far found are in the sandstones of the Medina formation, near the top of the latter. This formation outcrops in a belt along the south shore of Lake Ontario and consists mainly of shale with sandstones in the upper part, with an aggregate thickness of about 1200 feet. It extends along the lake shore from the Niagara river to Oswego county, and continues eastward for some distance beyond the limits of this county. The strata have been little disturbed or changed since their uplift. They dip slightly toward the south or southeast, the average inclination being about 50 feet to the mile. The dip together with the rising elevation toward the south soon brings the strata under a

considerable cover which increases progressively with the distance from the outcrop. The important gas pools of Erie and Genesee counties occur in the Medina at depths of from 1200 to 1800 feet, those in the southern part of Erie county being the deepest. The lake shore gas belt of Chautauqua county also derives its main supply from the Medina which is encountered at depths of 1900 to 2300 feet. The deepest explorations have been in northern Cattaraugus county, where gas sands supposedly belonging to the Medina have been encountered at 2500 to 3300 feet.

Next to the Medina, the most important horizon is in the Chemung sandstones at the top of the Devonic, the same strata that yield the petroleum production of New York. The wells are from 600 to 1800 feet deep and were primarily drilled for oil, but the gas is an important subsidiary product that is utilized in part for pumping the wells. The excess is piped to the communities in the district and as far as Buffalo.

The Trenton limestone affords a small supply of gas which is developed at Pulaski and Sandy Creek, Oswego county, at the east end of Lake Ontario and at Baldwinsville, Onondaga county. At the localities first named the wells are 1200 to 1500 feet deep and at Baldwinsville 2400 feet.

PETROLEUM

The oil wells last year yielded about the average product, as shown by the receipts of pipe-line companies who handle the New York output. The total receipts were 928,540 barrels, against 933,511 barrels in 1914 and 916,873 in 1913. For the last 20 years the production has held steadily at about the same level, fluctuating to a slight extent with the varying market conditions. When prices are low there is less activity in drilling and the increment from new wells falls short of balancing the natural decline in the flow of the older wells, so that the production falls off; whereas a rising market usually results in an increase of output.

While market conditions on the whole have favored the industry during the last few years, they have been subject to remarkable variations, so much so that producers could place little reliance upon their stability from month to month or day to day. Such rapid changes naturally have a tendency to unsettle and discourage plans for new undertakings. The causes for the rapid rise and fall in the quotations for crude oil during 1914 and 1915 have not been apparent from the viewpoint of the refined market.

The range of prices within the period of the year has been from \$1.35 to \$2.50 a barrel. In the early months of 1914 quotations remained steady at \$2.50. During the month of May there was a vertical drop to \$1.90 and by September they had reached \$1.45 where they held to the close of that year. In January 1915 Pennsylvania and New York crude was quoted at \$1.50. No change occurred until April when the price dropped to \$1.35. With the month of August an upward trend began which carried the quotations to \$1.45, to \$1.65 in September, \$1.75 in October, \$2.10 in November and \$2.25 in December.

Owing to the discouraging outlook at the close of 1914, with prices over \$1 a barrel below the quotations at the beginning, there was little enterprise manifested in exploratory work during the first months of the new year. There were fewer wells drilled in 1915 than had been reported for a number of years. The total, according to the monthly compilations of the Oil City Derrick, was 108, as compared with 267 in 1914, 512 in 1913, and 246 in 1912. The increment of production from the new wells amounted to 122 barrels, against 446 barrels in the preceding year, 810 barrels in 1913 and 278 barrels in 1912. There were two dry wells reported, as compared with 17 in 1915, 48 in 1913 and 66 in 1912.

Production of petroleum in New York

YEAR	BARRELS	VALUE
1896	1 205 220	\$1 420 653
1897	1 279 155	1 005 736
1898	1 205 250	1 098 284
1899	1 320 909	1 708 926
1900	1 300 925	1 759 501
1901	1 206 618	1 460 000
1902	1 119 730	1 530 852
1903	1 162 978	1 849 135
1904	1 036 179	1 709 770
1905	949 511	1 566 931
1906	1 043 088	1 721 095
1907	1 052 324	1 736 335
1908	1 160 128	2 071 533
1909	1 160 402	1 914 663
1910	1 073 650	1 458 194
1911	955 314	1 251 461
1912	782 661	1 338 350
1913	916 873	2 255 508
1914	933 511	1 773 671
1915	928 540	1 476 378

The statistics of production for the 20 year period, 1896–1915, are shown in the accompanying table. The figures up to the year 1903 inclusive are those compiled by the *Mineral Resources*, while the statistics of subsequent date have been collected directly from the pipe-line companies and shippers who operate in the New York fields. The list of these companies follows: Columbia Pipe Line Co., Union Pipe Line Co., Fords Brook Pipe Line Co., Buena Vista Oil Co., and Madison Pipe Line Co. of Wellsville; Vacuum Oil Co., Rochester; New York Transit Co., Olean; Emery Pipe Line Co., Allegany Pipe Line Co., Tide Water Pipe Co., Limited, and Kendall Refining Co., Bradford, Pa.

The production of oil comes from three counties — Allegany, Cattaraugus and Steuben. Altogether there are about 11,500 wells in the State, of which 8200 are in Allegany, 3000 in Cattaraugus and 300 in Steuben county.

The Allegany county wells are distributed over six townships situated along the Pennsylvania boundary. The field was opened about 1880 and in the height of its prosperity contributed 30,000 barrels a day. The principal pools are the Bolivar, Richburg, Wirt and Andover; the last named lies partly in Steuben county and is the source of its production of oil. The wells of Allegany county range from 780 to 1900 feet deep, and the oil sands attain a thickness of 50 feet or more in the best territory.

Cattaraugus county contains the extension of the Bradford field of Pennsylvania, with about 40 square miles of oil territory in the towns of Olean, Allegany and Carrollton. The more notable pools are the Ricebrook, Allegany, Chipmunk and Flatstone and are found at depths of from 600 to 1800 feet. The first wells were drilled in 1865.

SALT

A record year in the salt industry was indicated by the returns received from the mines and brine-pumping plants for 1915. The aggregate output of all grades of salt was 11,095,301 barrels, as compared with 10,389,072 barrels in the preceding year, and larger than the highest total previously reported, which was in 1913, by 275,780 barrels. The increase was brought about by enlarged operations of the producers and not by the development of new sources of supply. There were no additions to the list of enterprises either among brine works or mines.

As shown by the detailed statistical tables for 1914 and 1915, the increased output was not accompanied by any notable improvement in the market situation, so far as relates to prices. The average

selling price was the same in both years, although minor changes may be noted among the individual grades. In view of the strong upward trend of commodity prices that has been in evidence recently, the salt trade does not appear to be in a particularly prosperous condition.

The industry has experienced a tremendous expansion in the last quarter of a century, in which time the production has increased nearly fivefold. This is not entirely the result of the growth of the salt trade, strictly speaking, within the territory tributary to New York, although there has been a material gain in the trade; but is due largely to the development of chemical industries that consume salt, and especially of alkali or soda manufacture which has grown to large proportions in recent years. It is estimated that the amount of salt that is now converted into sodium compounds by manufacturers within the State amounts to fully one-third of the whole annual production of salt.

Production of salt by grades in 1914

GRADE	BARRELS	VALUE	VALUE A BARREL
Common fine *a*	1 369 071	$543 203	$.40
Common coarse	162 329	74 545	.46
Table and dairy	1 272 629	820 840	.64
Solar	328 700	90 392	.27
Packers	100 186	50 402	.50
Other grades *b*	7 156 157	1 256 324	.18
Total	10 389 072	$2 835 706	$.27

Production of salt by grades in 1915

GRADE	BARRELS	VALUE	VALUE A BARREL
Common fine *a*	1 460 379	$598 193	$.40
Common coarse	126 193	59 077	.46
Table and dairy	1 274 743	829 581	.65
Solar	267 886	93 760	.35
Packers	165 179	83 890	.50
Other grades *b*	7 800 921	1 347 431	.17
Total	11 095 301	$3 011 932	$.27

a Common fine includes a small amount of common coarse.
b Includes rock salt, salt in brine used for alkali manufacture, agricultural salt, and small amounts of brine salt for which the uses were not specified in the returns.

The classification, as given in the tables, is based on the commercial grades, so far as practicable. In case, however, a certain grade is made by a single producer, it is merged with other grades, so as not to reveal the individual figures. Rock salt and the salt in brine converted into soda appear in the last item of the tables, which includes also small amounts of evaporated salt not specially classified in the returns. Table and dairy salt includes the superior grades of artificially evaporated salt that are specially prepared for the table and for butter and cheese making; it brings the highest market prices. Under common fine are listed the other grades of fine, artificially evaporated salt that are not specially prepared. Common coarse represents the coarser product from artificial evaporation. Solar salt is made by evaporation of brine in shallow vats exposed to the sun's heat. The process is employed only by the manufacturers on the old Onondaga Salt Springs Reservation at Syracuse, and can be carried on of course only in the summer months. The product is used practically for the same purposes as rock salt. Packers salt includes the grade sold to meat packers and fish salters.

The salt industry is confined at present to six counties, as follows: Genesee, Livingston, Onondaga, Schuyler, Tompkins and Wyoming. Of these, Livingston county is the sole producer of rock salt; while the others are represented only in the evaporated salt industry, and derive their brines from wells sunk to the salt beds, or, in the case of the Onondaga county solar salt industry, from wells that yield a natural brine.

The following is a list of the active companies in the evaporating industry during 1915: International Salt Co., with works at Myers and Watkins; Worcester Salt Co., Silver Springs; Rock Glen Salt Co., Rock Glen; Remington Salt Co., Ithaca; Watkins Salt Co., Watkins; Genesee Salt Co., Piffard; Le Roy Salt Co., Le Roy; Solvay Process Co., Solvay, and the several makers of solar salt at Syracuse who market their output through the Onondaga Coarse Salt Association of that city. The rock salt mines, of which two were active, were worked by the Sterling Salt Co., Cuylerville, and the Retsof Mining Co., Retsof. One company, the Eureka Salt Corporation of Saltville, who made a production in 1914, was inactive last year.

The salt deposits of the State are widely distributed and of inexhaustible character. Practically all the territory to the south of the outcrop of the Salina formation, west from Madison county,

may be considered as within the salt-bearing district, although the deposits are not absolutely continuous throughout the area. Rock salt is not encountered usually at less than 800 feet or so from the surface, since the beds are very soluble and it is only under a protecting cover of considerable thickness that they have been preserved. They are known to continue far to the south of the Salina outcrop where the dip carries them to depths of over 3000 feet. The distribution of the salt beds and the industry based on them have been described by Merrill and Englehardt in Bulletin 11 of the New York State Museum, "Salt and Gypsum Industries of New York." Further and more recent data on the geology of the beds will be found in Luther's "Geology of the Livonia Salt Shaft" in the 13th Annual Report of the New York State Museum and "Salt Springs and Salt Wells of New York and Geology of the Salt District" in the 16th Annual Report of the Museum. Many records of salt wells are assembled in the papers by Bishop, included in the 5th Annual Report of the New York State Geologist and the 45th Annual Report of the State Museum.

The most recent exploration for salt has been in the vicinity of Portland Point, Cayuga county, on the east side of Cayuga lake, south of Ludlowville or Myers where the International Salt Co. has a brine works. According to information supplied by Fordyce A. Cobb, Esq., of Ithaca, the well was started in May 1915, and completed in August of the same year. The locality is about 10 rods north of the Cayuga Lake Cement Works, near the Lehigh Valley Railroad Company's tracks. Rock (limestone) was encountered at 11 feet. The salt bed was reached at 1484 feet. The upper 17 feet of salt was somewhat shaly and impure, but between 1501 and 1548 feet depth a fine quality of rock salt was passed through. No attempt toward development of the deposit has as yet been undertaken. The drill test is of interest as showing the continuation of the Ludlowville beds to the south, over a part of the interval between that place and the next proved territory just north of Ithaca where the Remington Salt Co. has a plant which derives brines from wells 2100 feet deep.

Production of salt in New York

YEAR	BARRELS	VALUE
1890	2 532 036	$1 266 018
1891	2 839 544	1 340 036
1892	3 472 073	1 662 816
1893	5 662 074	1 870 084
1894	6 270 588	1 999 146
1895	6 832 331	1 943 398
1896	6 069 040	1 896 681
1897	6 805 854	1 948 759
1898	6 791 798	2 369 323
1899	7 489 105	2 540 426
1900	7 897 071	2 171 418
1901	7 286 320	2 089 834
1902	8 523 389	1 938 539
1903	8 170 648	2 007 807
1904	8 724 768	2 102 748
1905	8 575 649	2 303 067
1906	9 013 993	2 131 650
1907	9 657 543	2 449 178
1908	9 005 311	2 136 736
1909	9 880 618	2 298 652
1910	10 270 273	2 258 292
1911	10 082 656	2 191 485
1912	10 502 214	2 597 260
1913	10 819 521	2 856 664
1914	10 389 072	2 835 706
1915	11 095 301	3 011 932

SAND AND GRAVEL

The production of sand and gravel should be given consideration as one of the branches of the mineral industry. It is carried on in one or more places in practically every county of the State; but only in a few sections has it become really stabilized so as to be conducted on a more or less permanent basis. For that reason a statistical investigation of the industry is attended with considerable difficulty, and the results may be lacking somewhat in accuracy.

Such is the case more especially with the ordinary building sands and gravels which are so widely distributed that in most places they have little or no intrinsic value, the requirements being supplied from deposits in the immediate vicinity at a nominal expense above the cost of handling. In recent years, however, there has been a manifest tendency toward a standardization of these materials when they are to be employed in important structures or engineering works. It has been found that they have a very direct influence upon the quality of the mortar or concrete into which they enter, a fact that has not received so wide appreciation as it

should perhaps, outside of the engineering profession. The need for materials that will meet the modern requirements has made necessary more care in the selection, besides preparation oftentimes by sizing or washing. This development is one that promises to place the industry upon a more settled basis than it has had in the past.

Sand also serves a variety of other uses, such as for glass manufacture, for making of molds for casting metals, as an abrasive, and in numerous manufacturing and metallurgical operations. In most of these applications the sands must meet certain definite requirements as to physical condition, mineral or chemical composition, which greatly limit the available sources of supply. Their production necessitates a degree of skill and technic which makes for permanency in the enterprises.

The sand and gravel beds of the State belong mainly to the Pleistocene formations, accumulated as the result of the great ice invasion which moved from north to south and reached as far south as northern New Jersey and Pennsylvania. This ice sheet swept the rocks bare of their former mantle of disintegrated materials and in their place left a covering of transported bowlders, gravels, sands and clays. These materials when deposited directly by the ice as ground moraine are so intermixed as to have little or no industrial value. Such unmodified drift covers a considerable portion of the area, especially in the hilly country, whereas in the valleys and lowlands it is usually concealed by beds of sorted gravels, sands and clays. These latter were deposited by the waters which issued from the glacier during its retreat. In some of the larger valleys, as those of the Hudson, Champlain and Genesee, as well as in numerous smaller ones, the glacial waters were held imprisoned for a time by dams so that they stood high above the present levels, and the sands and clays were deposited in a series of terraces in great thickness and in well-sorted arrangement.

Beach sands are found on the shores of Long Island and Staten Island and of some of the interior lakes, notably Oneida lake. These are characterized by a degree of uniformity and purity which make them valuable for many purposes. The sands that have been used most extensively for glass making are found on Oneida lake.

Production. The statistics of the sand and gravel industry, as collected from the individual producers, give an approximation of the total business, but it is not claimed that they are complete. The figures for molding sand, however, are full and reliable, since this branch of the trade is on a fairly stable basis, in contrast with the other branches which in general are subject to great changes from

year to year. The figures for building sand and gravel, doubtless, understate the actual business, falling short perhaps as much as 15 per cent of the total output in any one year. The operations are so widely scattered and often of so fugitive nature that it is not possible to keep informed of all developments as they take place.

Production of sand and gravel

MATERIAL	1913	1914	1915
Building sand	$1 102 688	$1 151 521	$1 185 812
Molding sand	449 224	310 727	415 073
Fire and core sand	38 571	23 944	24 797
Other sand	75 000	75 000	75 000
Gravel	918 783	650 895	965 336
Total	$2 584 266	$2 212 087	$2 666 018

Building sand and gravel. Building sand is employed in lime and cement mortars, for concrete, artificial stone, etc. It is desirable that sand for this use should be mainly composed of quartz which is the strongest and most durable of the minerals that occur in sands, but ordinarily the sands supplied consist of quartz mixed with considerable percentages of silicate minerals, especially feldspar, mica and hornblende. Silt and clayey matter are also present in most sands, especially those of glacial or stream origin.

For small structures where little stress is laid upon the elements of strength and permanency the silty mixed sands, if not too inferior in quality, may serve well enough, as in fact large quantities of such material are thus utilized with satisfactory results. It is also true that the tendency in building construction is toward a closer scrutiny and control of all the materials, inclusive of the sand and coarser aggregates. The strength of mortar and concrete is dependent quite as certainly upon the character of the sand as upon that of any other constituent, and in important works like highways, bridges and large buildings it is the practice now to require certain standards of texture and composition. Hence there has arisen an increased demand for the better grades which is serving to stabilize and centralize the industry. The requirements are such that the supplies are obtainable only from certain restricted areas or through artificial benefication of low-grade sands by washing and sizing.

The most important deposits from a commercial standpoint are those found on the northern shores of Long Island. These are dredged from shallow waters or excavated along the exposed beaches, and prepared by screening. Enormous quantities are taken each year from the northern shores of the island within the limits of Nassau county. The sand is shipped in barges to New York and the environs for use in buildings, street work, etc.

Some of the lake beaches in the interior of the State afford excellent building sands. Oneida lake is bordered by extensive sand beaches from which quartz sands, some of high quality, are obtained.

The output of building sand in 1915 was returned as 4,127,508 cubic yards, worth $1,185,812, a little over the output reported for the two preceding years. The output included some sand used for water filtration, which is obtained from the same beds as building sand.

Molding sand. The Hudson valley from Fort Edward south to Poughkeepsie contains extensive areas of fine sands which represent the last deposits formed in glacial Lake Albany.[1] They overlie the blue and yellow clays, deposited during the same period of flood waters, but have a rather variable vertical distribution owing to effects of wind erosion which in places has swept them away to heap them up elsewhere in dunes. The sand normally contains considerable shale, but through weathering the shale is resolved into clay with the release of some iron. The weathering is also marked by a change of color, from grayish to yellow. This yellow weathered sand is a pure quartz sand and is remarkable for the angularity and even size of the particles. It usually possesses also a fine grain. The combination of qualities makes it a valuable molding sand, especially for small castings like stove-plate and other iron work which require a smooth surface.

The business of excavating and shipping the sand of this district is extensive and is carried on by a number of concerns, each of which usually has several banks under operation so as to be in a position to supply the various grades in demand. The output in recent years has ranged from 300,000 to 500,000 short tons. In 1915 it amounted to 454,511 short tons valued at $415,073, which represented a large gain over the product reported in 1914 when the industry felt the effects of the general depression in the metal trades.

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[1] A detailed account of the molding sands of this region will be found in a paper by D. H. Newland in Trans. Amer. Foundrymen's Association, v. 24. 1914.

STONE

The products of the stone quarries form a large item in the total mineral production of the State. The last few years have witnessed, however, some notable changes in the relative importance of the different branches of the stone industry. The use of cement and terra cotta in architectural work has curtailed the demand for cut stone, so that this branch no longer occupies the prominent place that it once had. Similarly the market for flagstone and curbstone has fallen off, especially for flagstone, as a result of the favor shown for cement construction. On the other hand there has been a tremendous development of the crushed stone industry, which has practically counterbalanced the declines in the other departments. Altogether the changes that have taken place have meant a loss industrially, since the preparation of crushed stone requires a minimum of labor of the unskilled sort, while the cut stone business once gave employment to large numbers of highly trained workmen.

The statistics of stone production which have been supplied by the quarry operators throughout the State indicate that the year 1915 was a period of great depression for practically all branches of the industry. The decline in production coming after a period of such radical curtailment as shown by the returns for the preceding year in comparison with those for 1913, was significant of a reaction such as the industry has not experienced previously for a long time. The total value of the quarry materials amounted to $5,162,115 against $5,741,137 in 1914 and $6,763,064 in 1913. This represents a decline of 10 per cent for the past year and of 24 per cent in the output for the two years since 1913. The depression caused the closing of some quarries. There is little doubt that the decline has reached its lowest point, and hereafter an improvement may be expected, as in fact there has already been some change for the better.

The granite quarries made the best showing of all, but this was due largely to the product of a single quarry in southeastern New York which supplied stone for a large contract. The output of crushed stone and paving blocks is expected to increase during the current season through the addition of new producers to the list.

Limestone, as heretofore, constituted more than one-half of the total output in value. The product was but little smaller than that for 1914, the principal decrease being in the item of crushed stone.

Marble showed a drop of nearly 50 per cent which was distributed nearly proportionately between building and monumental stone. The active quarries were in the Gouverneur district and in Dutchess county.

The production of sandstone continued to decline as it has done for several years past. The depression affected the bluestone industry more especially, which supplies stone for street work. The Medina district fairly held its own.

The quarrying of trap was influenced by conditions other than those of supply and demand. The quarries along the face of the Hudson Palisades have been in process of condemnation, and it is expected their operations will be definitely terminated before long, while some properties have already been closed.

The production of the different kinds of stone for the last three years is shown in the accompanying tables.

Production of stone in 1913

VARIETY	BUILDING STONE	MONUMENTAL	CURBING AND FLAGGING	CRUSHED STONE	ALL OTHER	TOTAL VALUE
Granite........	$45 911	$17 013	*a*	$236 650	$36 068	$335 642
Limestone.....	101 198	....	$6 546	2 386 632	1 358 302	3 852 678
Marble........	127 556	81 330	....	....	43 406	252 292
Sandstone.....	285 645	....	682 984	46 267	306 376	1 321 272
Trap..........	....	....	....	1 001 170	....	1 001 170
Total.....	$560 310	$98 343	$689 530	$3 670 719	$1 744 152	$6 763 054

a Included under "All other."

Production of stone in 1914

VARIETY	BUILDING STONE	MONUMENTAL	CURBING AND FLAGGING	CRUSHED STONE	ALL OTHER	TOTAL VALUE
Granite........	$79 903	$10 952	....	$259 750	$16 637	$367 242
Limestone.....	81 409	....	$3 877	2 156 503	1 074 274	3 316 063
Marble........	142 223	70 797	....	8 000	9 222	230 242
Sandstone.....	217 508	....	490 222	36 143	313 117	1 056 990
Trap..........	....	....	....	770 600	....	770 600
Total.....	$521 043	$81 749	$494 099	$3 230 996	$1 413 250	$5 741 137

Production of stone in 1915

VARIETY	BUILDING STONE	MONUMENTAL	CURBING AND FLAGGING	CRUSHED STONE	ALL OTHER	TOTAL VALUE
Granite........	$261 091	$19 926	$1 165	$61 965	$78 450	$422 597
Limestone.....	63 121	....	1 627	2 072 852	1 040 100	3 177 700
Marble........	61 601	37 074	....	....	21 772	120 447
Sandstone.....	198 743	....	317 986	77 368	296 314	890 411
Trap..........	....	....	....	497 660	53 300	550 960
Total.....	$584 556	$57 000	$320 778	$2 709 845	$1 489 936	$5 162 115

GRANITE

Granite is both a specific and a general term. When used in the restricted scientific sense it means an igneous rock of thoroughly crystalline character in which the chief constituents are feldspar, quartz and mica. Such a rock has a massive appearance; that is, the constituents are uniformly distributed in every direction, and owing to the predominance of the feldspar and quartz the color is rather light, commonly gray or pink. As a variation to the uniform distribution of the minerals, the latter may develop a plane parallel arrangement through the influence of compression when the mass was still deeply buried in the earth's crust. A granite with this parallel or foliated texture is known as a granite gneiss.

The commercial definition of granite is much broader than that given and includes almost any of the crystalline silicate rocks (usually igneous) that possess the requisite physical qualities for use as architectural or monumental stone. In most cases the commercial product is actually a granite in the true sense, but not infrequently it may be a syenite which lacks quartz, or a diorite consisting of plagioclase, feldspar and hornblende, or anorthosite which contains little else than basic plagioclase feldspar. So-called black granites are mainly gabbros and diabases with a large proportion of the iron compounds — pyroxene, hornblende and magnetite.

The broader usage will be followed in the present classification, as all the above-named rocks are quarried in this State. The only silicate rock not included under granite is diabase or trap which, on account of the special features surrounding its production and uses, is classified by itself.

Granites and the associated crystalline silicate rocks are restricted in New York to two well-defined areas — the Adirondacks in the north and the Highlands in the southeast. A detailed account of these materials, their characters, distribution and economic development is given in "Quarry Materials of New York," issued as Bulletin 181 of the New York State Museum.[1]

The quarrying of granite has never attained the importance which seems commensurate with the resources and large markets of the State. Much of the output reported in recent years has been by contractors on local engineering works, rather than by permanent enterprises established for the supply of stone to the general market. The value of the product thus is difficult to establish. In the last year or two there has been manifest a more general interest in the industrial development of the granite resources which promises to give a new impetus to the production.

The output in 1915 was valued at $422,597 and consisted of building stone, $261,091; monumental, $19,926; paving blocks, $78,450; crushed stone 74,050 cubic yards, $61,965; other kinds, $1165. A large part of the building stone was quarried by a single firm for the construction of the Kensico reservoir at Valhalla, N. Y., which is built of cyclopean masonry.

Activity in the St Lawrence River district was confined to the operations of J. Leopold & Co. at their Alexandria Bay quarries where paving blocks were made. The quarries of the Picton Island Red Granite Co. were closed down. The Wisconsin Granite Co., one of the largest firms in the granite trade, has secured property on Wellsley island, where it will quarry stone for paving blocks, and has erected a crushing plant at Alexandria Bay.

The syenite quarries at Ausable Forks, which supply monumental stone of dark green color, were operated on about the usual scale. The Champlain Green Granite Co. and Fred A. Carnes were the producers.

The anorthosite quarries in the northern Adirondacks are among the properties that should contribute materially to the output, once the stone becomes familiar to the public. The material is nearly pure feldspar, white to grayish green on the rock face and a beautiful lustrous green on polished surfaces. A dark gray gneissic granite was quarried by E. F. Edel near Gloversville, principally for paving blocks.

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[1]January 1, 1916.

The Mohegan Granite Co. continued work in its quarries near Peekskill, from which are obtained yellow and light gray granites adapted to building and monumental work.

H. S. Kerbaugh Co., Inc., operated the Valhalla quarries in the Yonkers granite. This is the largest enterprise in the State, most of the product being used locally in engineering work, although some of the output was sold. The stone is well suited for general building purposes.

LIMESTONE

The stone classified under the heading of limestone consists for the most part of the common grades of limestone and dolomite, such as are characterized by a compact granular or finely crystalline texture and are lacking in ornamental qualities.

A smaller part is represented by crystalline limestone and by the waste products of marble quarrying which are sometimes employed for crushed stone, lime-making or flux. Limestone used for the manufacture of portland and natural cement is, however, excluded from the tabulations so as to avoid any duplications of the statistics.

Limestones have a wide distribution in the State, the only region which is not well-supplied being the southern part where the prevailing formations are sandstones of Devonic age. The microcrystalline varieties occur in regular stratified order in the Cambric, Lower Siluric, Upper Siluric and Devonic systems. In most sections they occupy considerable belts and have been little disturbed from their original horizontal position. On the borders of the Adirondacks and in the metamorphosed Hudson river region, however, they have been more or less broken up by faulting and erosion and in places have a very patchy distribution.

The Cambric limestones are found in isolated areas on the east, south and west of the Adirondacks. They are usually impure, representing a transition phase between the Potsdam sandstones below and the high calcium limestones above. The lower beds of the Beekmantown formation as originally defined are now known to belong to the Cambric system. The Little Falls dolomite is perhaps the most prominent member of the Cambric limestones and is extensively developed in the Mohawk valley with quarries at Little Falls, Amsterdam, and other places. It is a rather heavily bedded stone of grayish color, suitable more especially for building purposes. In Saratoga county the Hoyt limestone is in part the equivalent of the Little Falls dolomite; it has been quarried for

building stone just west of Saratoga Springs. On the west side of the Adirondacks the Theresa limestone is described by Cushing as a sandy dolomite which may in part belong to the Cambric system. It is comparatively thin and has no importance for quarry purposes.

The Beekmantown limestone, which is now taken as including the middle and upper beds of that series as earlier defined, is mostly restricted to the Champlain valley. It occurs on the New York shore in rather small areas, usually downfaulted blocks, that are the remnants of a once continuous belt. It is also doubtless represented in the basal portion of the limestone area that extends across Washington and Warren counties. The only place where it has been extensively quarried is at Port Henry where the purer layers have been worked for flux. In the Lake Champlain region it is a bluish or grayish magnesian limestone occurring in layers from a few inches to several feet thick.

The Chazy limestone is found in the same region as the Beekmantown in discontinuous areas along the eastern Adirondacks from Saratoga county north to the Canadian boundary. It attains its maximum thickness in eastern and northeastern Clinton county, and has been quarried around Plattsburg, Chazy and on Valcour island. The Chazy is the earliest representative of the Paleozoic formations characterized by a fairly uniform high calcium content; it analyzes 95 per cent or more of calcium carbonate. It has a grayish color and finely crystalline texture. The fossiliferous beds afford attractive polished material which is sold as "Lepanto" marble. It is used also for lime and furnace flux. There are old quarries on Willsboro point, Essex county. On the west side of the Adirondacks the Pamelia limestone, described in the areal reports of that section, belongs to the Chazy series. It covers a considerable area in Jefferson county between Leraysville and Clayton, and has been rather extensively quarried for building stone and lime, though of subordinate importance to the Trenton limestones of that section.

In the Mohawkian or Trenton group are included the Lowville (Birdseye), Black River and Trenton limestones which have a wide distribution and collectively rank among the very important quarry materials of the State. They are represented in the Champlain valley but are specially prominent on the Vermont side; from the latter area a belt extends southwest across northern Washington county to Glens Falls in Warren county and is continued into Saratoga county. Another belt begins in the Mohawk valley near Little Falls and extends northwesterly with gradually increasing

width across Oneida, Lewis and Jefferson counties to the St Lawrence river. There are isolated areas of Trenton limestone in the Hudson valley south of Albany. The limestones vary in composition and physical character according to locality and geologic position. They are often highly fossiliferous. In the northern section they are mostly gray to nearly black in color, contain little magnesia and run as high as 97 or 98 per cent calcium carbonate. The lower part of the group is heavily bedded and well adapted for building stone; the upper beds commonly contain more or less shale. They are used for various purposes including building and ornamental stone, crushed stone, lime, portland cement and flux. In the Champlain valley quarries are found near Plattsburg, Larabee's Point and Crown Point; in Washington county at Smith's Basin; in Warren county at Glens Falls where there are extensive quarries that supply material for building purposes, portland cement and lime. The well-known black marble from Glens Falls is taken from the Trenton. Numerous quarries have been opened in Herkimer, Oneida, Lewis and Jefferson counties. The output of the last named county is specially important, including limestone for building and road construction and lime for manufacture of calcium carbide. The principal quarries in Jefferson county are at Chaumont.

The next assemblage of limestones in the order of stratigraphic occurrence includes the Clinton, Lockport and Guelph members of the Niagara group. The Clinton limestone has a variable importance in the belt of Clinton strata that extends from Otsego county a little south of the Mohawk river across the central and western parts of the State on the line of Oneida lake and Rochester to the Niagara river. East of Rochester the limestone is relatively thin, usually shaly and split up into several layers, but on the west end in Niagara county it becomes the predominant member and has a more uniform character. Large quarries have been opened recently at Pekin, Niagara county, for the supply of flux to the blast furnaces of the Lackawanna Steel Co., at Buffalo. The upper beds of bluish gray fossiliferous limestone from 10 to 12 feet thick are the purest and analyze from 90 to 95 per cent calcium carbonate. The Lockport is a magnesian limestone, in places a typical dolomite, and is rather silicious in the lower part. It outcrops in a continuous belt, several miles wide, from Niagara Falls east to Onondaga county and then with diminishing width across Madison county. The upper layers are rather heavy and yield material suitable for building purposes, road metal and lime. There are quarries around Niagara Falls, Lockport and Rochester. It is

worked to some extent in Wayne, Onondaga and Madison counties. The Guelph, also a dolomite, occupies a limited area in Monroe and Orleans counties and is worked near Rochester.

The Cayugan group includes among its members the Cobleskill, Rondout and Manlius limestones, which are economically important. They have furnished large quantities of material for the manufacture of natural cement, being the source of the cement rock in the Rosendale district and in Schoharie and Onondaga counties. The cement rock of Erie county is found in the Salina formation. The Manlius limestone is used for portland cement in the eastern part of the State.

At the base of the Devonic system appears the Helderbergian group which is very important for its calcareous strata. Limestones of this age are strongly developed along the Hudson river in Albany, Columbia, Greene and Ulster counties. The Coeymans or lower Pentamerus and the Becraft or upper Pentamerus limestones afford material for building, road metal, lime and portland cement. The limestone for the portland cement works at Hudson and Greenport is obtained from Becraft mountain, an isolated area of limestones belonging to the Manlius, Helderbergian and Onondaga formations. The works at Howes Cave use both the Manlius and Coeymans limestones. Extensive quarries are located also at Catskill, Rondout and South Bethlehem.

The Onondaga limestone, separated from the preceding by the Oriskany sandstone, has a very wide distribution, outcropping almost continuously from Buffalo eastward to Oneida county and then southeasterly into Albany county, where the belt curves to the south and continues through Greene, Ulster and Orange counties to the Delaware river. It is in most places a bluish gray, massive limestone with layers and disseminated nodules of chert. The chert is usually more abundant in the upper beds. The limestone finds use as building stone and the less silicious materials also, for lime-making. Quarries have been opened at Kingston, Split Rock (near Syracuse), Auburn, Waterloo, Seneca Falls, Le Roy, Buffalo and other places.

The Tully is the uppermost of the important limestone formations and likewise the most southerly one represented in the central part of the State. Its line of outcrop extends from Ontario to Madison county, intersecting most of the Finger lakes. Its thickness is not over 10 feet, and on that account can not be worked to advantage except under most favorable conditions of exposure. For building stone it is quarried only locally and to a very limited

extent. It finds its principal use in portland cement manufacture, being employed for that purpose by the Cayuga Lake Cement Co., in its works at Portland Point, Tompkins county.

Marl is a useful substitute for the hard limestone for some purposes and is rather extensively developed in the central and western parts of the State. It is found particularly in swampy tracts and old lake basins associated with clay and peat. In the Cowaselon swamp near Canastota the marl underlies several thousand acres and is said to be 30 feet thick. The Montezuma marshes in Cayuga and Seneca counties contain a large deposit which at Montezuma is 14 feet thick. In Steuben county the marls at Arkport and Dansville have been employed for lime-making. Until recently marls have been used extensively for portland cement and plants were operated at one time in the marl beds near Warner and Jordan, Onondaga county; at Montezuma, Cayuga county; Wayland, Steuben county; and Caledonia, Livingston county. Their principal use at present is for agricultural and chemical purposes.

Production. As already noted in a previous paragraph, limestone ranks first among the quarry materials of the State. The value of the output is larger than that of all other kinds together, and has gained in relative importance within the last few years. Its main use is as crushed stone for concrete and road work; most of the stratified formations, except those in the Upper Devonic, contain limestones that are adapted to that purpose. It is also employed as building stone, though not so extensively as formerly, and considerable quantities are consumed as reagent in chemical manufacturing and as flux in the iron and steel industries. Of late there has been a growing demand for finely ground limestone and burnt lime for agricultural uses. Lime manufacture still holds a prominent place in the industry.

The production of limestone, like that of other quarry materials, showed a decline in 1914 owing to the general dulness in building and other trades. The reaction continued into 1915 and brought about a further diminution in the output, although before the close of the year a distinct improvement had set in. The total value of limestone quarried was $3,177,700, against $3,316,063 in 1914.

Altogether 87 quarries reported as active, or 4 less than in the preceding year, distributed among 29 counties of the State. The accompanying tables give the statistics for the last two years, divided as to principal counties and the different uses for which the stone was sold.

Erie county has the largest industry of any; the value of the output quarried in the county in 1915 was $601,465. Its products chiefly are crushed stone, furnace flux and dimension stone. The quarries are situated in North Buffalo, Clarence and Akron. The Kelley Island Lime and Transportation Co. sold its quarry at Akron to the General Crushed Stone Co.

Onondaga county is second in rank as a producer and last year reported an output valued at $495,004, which was larger than in 1915. The quarries are situated in the Onondaga and underlying formations which stretch across the county south of Syracuse. One of the largest quarries is that of the Solvay Process Co. which uses the product largely in their alkali works at Solvay near Syracuse.

Other counties reporting values of over $100,000 in 1915 were Niagara, Dutchess, Genesee, Rockland, Ulster, Warren and Westchester, named in order of their rank.

Crushed stone. This item includes road metal, railroad ballast and concrete. The larger quarries supplying these materials are in Erie, Genesee, Onondaga, Dutchess, Ulster, Rockland and Westchester. The "fines" from some of the crushing plants are sold for agricultural use, the sales being entered under "other uses." The value of the crushed stone for 1915 showed a small decrease, as compared with that reported for 1914, and totaled $2,072,852, against $2,156,503. The total does not include stone crushed by contractors on the highway system, but the value of such stone is relatively small. The quantity of stone reported by the crushing plants was 2,985,347 cubic yards, against 3,306,325 in 1914.

Lime. The value of the lime made for the market last year was $387,083, as compared with $370,377 in 1914. In quantity the product amounted to 83,627 short tons, against 82,944 short tons in 1914. The greater part of the output was building lime, but a considerable proportion consisted of material for paper and chemical purposes and agricultural lime. A new feature of the trade was the inquiry for magnesian limes to supply the place of imported magnesite, especially for the manufacture of refractory furnace linings. The supply of magnesite which formerly came from Austria and Greece has been practically cut off by the European War, and manufacturers have resorted to dolomite as a substitute. One quarry in the Adirondack region made a speciality of magnesian lime for the purpose named. The principal lime burners are in Warren, Washington, Clinton, Fulton, Lewis and Dutchess counties.

Building stone. A further decline in the output of dimension stone is noted for 1915. The reported value of $63,121 was smaller than for any year previously covered by detailed statistics and represented about one-third of the value of such stone quarried 10 years ago. The decline can be traced largely to the change that has taken place in methods of building construction, whereby such materials as concrete, tile and terra cotta are substituted for cut stone. Artificial stone which produces the effect of the natural material is also now coming into use. It is made usually from selected aggregates like crushed pegmatite, marble, etc. with a minimum of cement as binder, and being formed in molds is given any desired shape without the expense of cutting.

Furnace flux. The metallurgical establishments of the State, notably iron and steel works, consume large quantities of fluxing limestone, which is obtained largely from local sources. Calcium limestones are mainly used, and the principal requisite is that they contain little of siliceous or aluminous impurities, and be free of phosphorus and sulphur. The larger flux quarries are in the Onondaga limestone of Erie and Genesee counties; the Clinton limestone of Niagara county, the Chazy limestone of Clinton county; and the Precambric crystalline limestones of the Adirondack region. The production of flux in 1915 was 822,729 short tons, valued at $440,-237, a slight increase in quantity but a decrease in value as compared with the output for the preceding year. Niagara and Erie counties lead in this branch of the industry.

Agricultural lime. The sales of lime for agricultural use have become in the last few years an important factor in the quarry business. The actual quantities thus marketed are not stated separately in the tables, for the reason that many of the quarries have no record of the amount that is so used. Some of the material that finds employment as land amendment is really a by-product of which little account is taken, as in the case of the fines and dust of the crushing plants which are sometimes marketed, and also the inferior grades of burnt lime. It is estimated that over 100,000 tons of agricultural limestone in crushed or calcined state were sold last year by the quarries of the State.

The possibilities of the trade have received much attention in the last few years, and quarry lands favorably situated with respect to markets have been in request. Inasmuch as the material must be delivered to the consumer at a low cost to make it economically available, the tendency is to develop local sources of supply in so far as they are at hand.

The resources in limestone suitable for agricultural use are rather widespread, but they are not always within easy reach of markets. They are most abundant in the northern section, particularly on the borders of the Adirondacks and the adjacent regions to the south, where they occur in the Precambric and early Paleozoic formations. The crystalline limestones or marbles of St Lawrence, Jefferson, and Lewis counties and the Trenton and Chazy stratified limestones of the Champlain and Mohawk valleys are among the best high calcium rocks. Some agronomists hold the view that magnesium above a small amount is detrimental, while others are of the opinion that it may perform a useful function or at least have no harmful effect if not existing in a proportion of more than about one-half that of lime. Supplies of magnesian limestones occur in Highlands and Taconic sections and also in the central and western counties. The southern tier of counties on the Pennsylvania border are devoid of carbonate rocks.

Production of limestone by counties in 1914

COUNTY	CRUSHED STONE	LIME MADE	FURNACE FLUX	BUILDING STONE	OTHER USES	TOTAL
Albany	$101 022					$101 022
Cayuga	49 860			$14 124		63 984
Clinton	14 917	$61 462	$12 423	3 500	$10 616	102 918
Dutchess	322 970	26 050				349 020
Erie	478 127		177 764	44 939	4 035	704 865
Genesee	156 302		40 000	600		196 902
Greene	4 039					4 039
Herkimer	700					700
Jefferson	10 992	11 600			2 700	25 292
Lewis	3 700			217		3 917
Madison	43 498	55 896				99 394
Monroe	20 027	4 898		1 021		25 946
Montgomery	6 400			4 576	744	11 720
Niagara	6 780		190 334	300	5 700	203 114
Oneida	74 741					74 741
Onondaga	148 106			6 193	231 036	385 335
St Lawrence	3 937	4 500	22 172	2 440	274	33 323
Schoharie	108 241			416		108 657
Ulster	208 720	7 740				216 460
Warren	18 406	129 281		1 708	5 343	154 738
Washington		40 000		1 000		41 000
Other counties	375 018	28 950	4 184	375	449	408 976
Total	$2 156 503	$370 377	$446 877	$81 409	$260 897	$3 316 063

Production of limestone by counties in 1915

COUNTY	CRUSHED STONE	LIME MADE	FURNACE FLUX	BUILDING STONE	OTHER USES	TOTAL
Albany	$92 003	....	....	....	....	$92 003
Cayuga	33 003	....	....	$7 060	....	40 063
Clinton	31 853	$47 373	$17 373	....	....	96 599
Dutchess	236 106	40 365	....	....	....	276 471
Erie	469 374	....	90 707	39 590	$1 794	601 465
Genesee	196 964	11 560	38 000	....	13 500	260 024
Greene	1 920	....	....	....	....	1 920
Herkimer	8 866	....	....	....	1 975	10 841
Jefferson	18 153	10 145	....	319	17 165	45 782
Lewis	3 300	30 000	....	80	....	33 380
Madison	17 166	....	....	....	13 762	30 928
Monroe	14 132	....	....	590	....	14 722
Montgomery	31 500	....	....	2 977	300	34 777
Niagara	24 847	....	267 845	1 660	19 199	313 551
Oneida	48 190	....	....	....	....	48 190
Onondaga	357 600	....	....	5 300	132 104	495 004
St Lawrence	13 334	4 725	25 762	285	1 365	45 471
Schoharie	76 034	402	....	2 763	6 787	85 986
Ulster	145 794	19 017	....	....	300	165 111
Warren	13 713	138 381	....	1 247	4 930	158 271
Washington	....	60 000	....	1 250	....	61 250
Other counties	239 000	25 115	550	....	1 226	265 891
Total	$2 072 852	$387 083	$440 237	$63 121	$214 407	$3 177 700

MARBLE

Marble, in the commercial sense, like granite, includes a variety of rocks that lend themselves to building or decorative uses. Most commonly, the name signifies a crystalline aggregrate of calcite or dolomite, as distinguished from ordinary limestones which at best are of indistinctly crystalline nature. At the same time it implies the feature of attractiveness by reason of color and the ability to take a lustrous polish. Rocks possessing all these features are marbles in the strict sense to which the name may be applied without qualification. Some compact or granular limestones that lack the elements of thorough crystallinity make, however, a handsome appearance when polished, and such are commercially classed as marbles. Fossil marbles, black marbles, and a few other kinds are commonly of the noncrystalline type. Serpentine marble, or verde antique, is made up for the most part of the mineral serpentine, a silicate of magnesium and iron, and is therefore not related to the varieties already described. Ophitic limestone, or ophicalcite, is a

crystalline limestone or dolomite carrying grains and nodules of serpentine scattered more or less evenly through its mass. Its ornamental quality lies in the speckled or mottled pattern and the sharp contrast between the clear white mass and the greenish serpentine inclusions.

Marbles belonging to those various types find representation in the geologic formations of the State and are quarried on a commercial scale or have been so quarried in the past.

The true or crystalline varieties are limited in occurrence to the metamorphic areas of the Adirondacks and southeastern New York. They are of early geologic age, antedating the period of crustal disturbance and metamorphism which in the Adirondacks was brought to a close practically before Cambric time and which in southeastern New York was completed in the Paleozoic. This thoroughly crystalline character is in fact a development of the strong compression accompanied by heat to which they have been subjected; having been originally, no doubt, ordinary granular or fossiliferous limestones similar to those so plentifully represented in the undisturbed formations outside the regions.

The crystalline limestones of the Adirondacks are most abundant on the western border in Jefferson, Lewis and St Lawrence counties where they occur in belts up to 4 or 5 miles wide and several times as long, interfolded and more or less intermixed with sedimentary gneisses, schists and quartzites. They are found in smaller and more irregularly banded areas in Warren and Essex counties on the eastern side, but have little importance elsewhere. The ophitic limestones that have been quarried at different times belong to the same series. The marbles of the Adirondacks comprise both the calcite class with very little magnesia and the dolomite class containing high percentages of magnesia. No definite relations is apparent in regard to the occurrence of the two and both may be found in the same area and in close association.

The southeastern New York marbles occur in belts which follow the north-south valleys, east of the Hudson, from Manhattan island into Westchester, Dutchess and Columbia counties. They range from very coarsely crystalline to finely crystalline rocks, are prevailingly white in color and belong to the dolomite class. They are interfolded with schists and quartzites, the whole series having steep dips like those of strongly compressed strata. The geologic age of the southern belts is probably Precambric, but on the north and east within range of the Taconic disturbance, they may belong to the early Paleozoic.

Bodies of practically pure serpentine of considerable extent are found on Staten Island and in Westchester county near Rye; they represent intrusions of basic igneous rocks whose minerals, chiefly pyroxene and olivine, have subsequently changed to serpentine. They are not important for quarry purposes, owing to the frequency of fissures and joints and the rather somber color of the exposed part of the masses.

The microcrystalline or subcrystalline limestones that are sometimes sold as marbles include members of the regularly bedded unmetamorphosed Paleozoic limestones, which locally show qualities of color and polish that make them desirable for decorative purposes. They range from dense granular varieties to those having a more or less well-developed crystalline texture and are often fossiliferous. Inasmuch as they have never been subjected to regional compression or been buried in the earth deep enough to become heated, the crystalline texture, when present, may be ascribed to the work of ground waters. These circulate through the mass, taking the carbonates of lime and magnesia into solution, and redeposit them in crystalline form. Originally, the limestones were accumulations of lime-secreting fossils or granular precipitates, for the most part of marine origin. Some of the localities where these unmetamorphic marbles occur are on the west shore of Lake Champlain, around Plattsburg and Chazy (Chazy limestone), Glens Falls (Trenton limestone) and Becraft and Catskill (Becraft limestone).

Production. The marble quarries reported a very poor business in 1915, the output amounting to about one-half that of the average for previous years. The depression affected both building and monumental quarries. The number of firms reporting a production was seven, distributed among Dutchess and Westchester counties in southeastern New York and St Lawrence and Warren counties in the Adirondack region. In the Gouverneur district the St Lawrence Marble Quarries and the Gouverneur Marble Co. alone were active. The Northern New York Marble Co. of that place went out of business. The quarries of the South Dover Marble Co. at Wingdale were worked as heretofore, though on a reduced scale. In Westchester county the old "Prison" quarry at Ossining was reopened for the purpose of getting out dimension stone for the remodeling of the State Hall at Albany, which is constructed of marble from this quarry.

The production of marble altogether was valued at $120,447 against $230,242 in 1914 and $252,292 in 1913. Of the product,

building stone, rough and dressed, accounted for $61,601 and monumental for $37,074 against $142,223 and $70,797 respectively in 1914. Other kinds of marble quarried had a value of $21,772 against $17,222 in 1914.

SANDSTONES

Under sandstones are included the sedimentary rocks which consist essentially of quartz grains held together by some cementing substance. Among the varieties distinguished by textural features are sandstones proper, conglomerates, grits and quartzites.

Of the sedimentary rocks which occur in the State, sandstone has the largest areal distribution, while in economic importance it ranks second only to limestone. Nearly all the recognized stratigraphic divisions above the Archean contain sandstone at one or more horizons. The kinds chiefly quarried are the Potsdam, Hudson River, Medina and Devonic sandstones. A few quarries have been opened also in the Shawangunk conglomerate and the Clinton and Triassic sandstones.

The Potsdam of the Upper Cambric is the lowest and earliest in age of the sandstones that have a fairly wide distribution and are utilized for building purposes. The most extensive outcrops are along the northern and northwestern borders of the Adirondacks, in Clinton, Franklin, St Lawrence and Jefferson counties. Other exposures of smaller extent are found in the Lake Champlain valley and on the southeastern edge of the Adirondack region. These latter areas represent the remnants of a once continuous belt that has been broken up by folding, faulting and erosion. The Potsdam sandstone has in many places the character of a quartzite, consisting of quartz grains cemented by a secondary deposition of quartz, and then is a very hard, tough and durable stone. The quartzite from St Lawrence county has sustained a crushing test of more than 42,000 pounds to the square inch. The color varies from deep red to pink and white. The principal quarries are near Potsdam and Redwood, St Lawrence county, and Malone and Burke, Franklin county. Besides building stone, which is the chief product, there is some flagstone sold, mainly by the quarries at Burke, for shipment to Montreal.

The so-called Hudson River group is essentially a group of sandstones, shales, slates and conglomerates, ranging in age from the Trenton to the Lorraine, but which have not been sufficiently studied to permit the actual delimitation of the various members on the map. The group is exposed in a wide belt along the Hudson

from Glens Falls southward into Orange county and also in the Mohawk valleys as far west as Rome. The sandstone beds are usually fine grained, of grayish color and rather thinly bedded. Over wide stretches they provide practically the only resource in constructional stone and consequently they have been quarried at a great number of places to supply the local needs for building and foundation work. Some of the stone is crushed for road metal and concrete.

The Medina sandstone is found along the southern shore of Lake Ontario from the Niagara river east to Oswego county; in central New York it is represented by a coarse conglomeratic phase called the Oneida conglomerate. As developed in the western part of the State, where it is principally quarried, it is hard fine-grained sandstone of white, pink and variegated color. The pink variety is specially quarried for building stone and has an excellent reputation. Many of the larger cities of the country and most of the important towns and cities of the State contain examples of its architectural use. The large quarries are situated in Orleans county, near Albion, Holley and Medina, along the line of the Erie canal, but there are others at Lockport and Lewiston, in Niagara county, and at Brockport and Rochester in Monroe county. The Medina sandstone also finds extensive applications for curbing and flagging and for paving blocks. It is employed more extensively for the latter purpose than any other stone quarried in the State.

The Shawangunk conglomerate is more widely known for its use in millstones than for constructional purposes. It outcrops along Shawangunk mountain in Ulster county and southwesterly into New Jersey, with an outlier near Cornwall, Orange county. The quarries near Otisville have supplied considerable quantities of stone for abutments and rough masonry.

The Clinton sandstone is mainly developed in central New York, being absent from the Clinton belt in the western part of the State. It forms ledges of considerable extent on the south side of the Mohawk valley from Ilion to Utica and beyond. It consists of reddish brown and gray sandstones, of medium texture and hardness. The stone has been used for foundations and building in Utica and other places in the vicinity.

Of the Devonic formations which cover about one-third the whole area of the State, the Hamilton, Portage, Chemung and Catskill contain important sandstone members serviceable for quarry operations. These sandstones are popularly known as bluestones, a name first applied in Ulster county where they are distinguished by a bluish gray color. They are for the most part fine

grained, evenly bedded, bluish or gray sandstones, often showing a pronounced tendency to split along planes parallel to the bedding so as to yield smooth, thin slabs. For that reason they are extensively used for flag and curbstone, and a large industry is based on the quarrying of these materials for sale in the eastern cities. Most flagstone is produced in the region along the Hudson and Delaware rivers, where there are convenient shipping facilities to New York, Philadelphia and other large cities. The Hudson River district includes Albany, Greene and Ulster counties, but the quarries are mainly situated in the area that includes southern Greene and northern Ulster, with Catskill, Saugerties and Kingston as the chief shipping points. The Delaware River district includes Sullivan, Delaware and Broome counties; the shipping stations are along the Erie and Ontario & Western Railroads. The sandstone of this section ranges from Hamilton to Catskill age. In the area to the west the quarries are confined to the Portage and Chemung groups, with the most important ones in the Portage. There are large, well-equipped quarries near Norwich, Chenango county, and Warsaw, Wyoming county, which produce building stone for the general market. Numerous small quarries are found in Otsego, Chemung, Tompkins, Tioga, Schuyler, Steuben, Yates, Allegany, Cattaraugus and Chautauqua counties.

Production of sandstone. Sandstone, by reason of its adaptability and its wide distribution, is extensively quarried in the State, ranking next to limestone in commercial importance. The larger part of the output is employed in street work in the form of curbstone, flagstone and paving blocks, but an important quantity is also used as building stone. It finds very little application as crushed stone on account of its platy fracture.

The Devonic sandstones, which are collectively known as bluestone, are more widely quarried than the other kind; this production is carried on throughout the southern part of the State by a large number of individuals and companies. With few exceptions, the quarries are small, giving employment to only two or three workmen each and having very little in the way of mechanical equipment. Such small enterprises are particularly characteristic of the Hudson River and Delaware River regions where much of the flagstone and curbstone is produced. Many of the quarries are worked intermittently by farmers in the off season of their usual occupation. The stone is hauled down the hillside to the railroad sidings or the river docks where it is purchased by middlemen who ship it to the eastern markets. The stone from the Hudson River district is mainly shipped by barges from Kingston and Saugerties. In the

interior it is shipped by rail. A statistical canvass of such small enterprises is a matter of great difficulty and is likely to afford very unreliable results. Consequently, it has been the practice in the compilation of this report to secure the information so far as possible from dealers who purchase the stone for shipment to the large wholesalers and consumers in the cities.

The production of sandstone during the last two years is shown in the accompanying tables which give its distribution also among the leading districts.

The combined value of all the sandstone quarried in 1915 was $890,411 against $1,056,990 in 1914, indicating a decline of about 16 per cent in the amount of sales for the year. This was a smaller output than in any recent year previously and is largely accounted for by the falling off in the bluestone industry. The totals are exclusive of sandstone quarried by contractors for use on the state highway system, for which it is impossible to assign any accurate value.

Of the combined value given, considerably less than one-half was returned by the quarry companies operating in the bluestone districts, whereas in previous years this branch of the industry was much the more important. The reported value of the bluestone actually was $339,779, as compared with $546,314 in 1914. Most of the decline may be attributed to the conditions in the curb and flagstone trade which has had to meet increasing competition from other materials, notably concrete and granite, in street work. This is indicated by the fact that the total value of curb and flagstone made from bluestone was only $155,288 as compared with $337,488 in 1914. A small decrease may be noted also in building stone, the value of which was $178,577 in 1915, against $191,239 in the preceding year.

Sandstone other than bluestone represented a value of $550,632, a gain over the figure for 1914 which was reported as $510,676. Orleans county by itself accounted for a value of $449,620 as compared with $439,635 in 1914. There was a good demand for paving blocks which constitute the principal product of this district.

Altogether the general situation last year was not very favorable for the quarry companies in the sandstone districts. Only a few new operations were reported, the more important being quarries for crushed stone production in Albany and Ulster counties. On the other hand, several quarries that were active in former years were closed without any prospect of immediate reopening.

Production of sandstone in 1914

DISTRICT	BUILDING STONE	CURBING AND FLAGGING	PAVING BLOCKS	CRUSHED STONE	RUBBLE RIPRAP	ALL OTHER
Bluestone						
Hudson river........	$5 500	$153 436	....	....	....	$1 559
Delaware river.......	20 196	177 200	....	....	$1 425	9 865
Chenango county.....	69 255	5 812	....	....	960	2 337
Wyoming county.....	92 201	1 000	....	$48	1 393	....
Other districts........	4 087	40	....	....	....	....
Total bluestone...	$191 239	$337 488	....	$48	$3 778	$13 761
Sandstone						
Orleans county.......	$15 926	$147 970	$266 775	....	$1 319	$7 645
Other districts........	10 343	4 764	12 912	$36 095	6 927	....
Total sandstone..	$26 269	$152 734	$279 687	$36 095	$8 246	$7 645
Combined total.......	$217 508	$490 222	$279 687	$36 143	$12 024	$21 406

Production of sandstone in 1915

DISTRICT	BUILDING STONE	CURBING AND FLAGGING	PAVING BLOCKS	CRUSHED STONE	RUBBLE RIPRAP	ALL OTHER
Bluestone						
Hudson river.........	$3 235	$44 243	....	....	....	$500
Delaware river.......	12 281	96 402	....	$237	$2 394	1 800
Chenango county.....	50 661	9 643	....	....	....	....
Wyoming county.....	104 829	....	....	15	720	248
Other districts........	7 571	5 000	....	....	....	....
Total bluestone..	$178 577	$155 288	....	$252	$3 114	$2 548
Sandstone						
Orleans county.......	$13 926	$160 441	$254 081	$19 931	$1 000	$241
Other districts........	6 240	2 257	11 276	57 185	5 500	18 554
Total sandstone..	$20 166	$162 698	$265 357	$77 116	$6 500	$18 795
Combined total.......	$198 743	$317 986	$265 357	$77 368	$9 614	$21 343

TRAP

Trap is not a distinct rock type, but the name properly belongs to the fine-grained, dark-colored igneous rocks that occur in intrusive sheets and dikes. In mineral composition it differs from

most of the igneous rocks that are classed in the trade as granite by the prevalence of the basic plagioclase feldspars and the higher percentages of the iron magnesia minerals, while it contains no quartz. Some of the so-called "black granites," however, are trap. The name is sometimes applied to fine-grained rocks of granitic or syenitic composition and sometimes even to rocks of sedimentary derivation, but such usage is misleading and indefensible.

The particular value of trap is due to its hardness and toughness. Its fine, compact, homogeneous texture gives it great wearing powers and it is eminently adapted for road metal and concrete of which heavy service is required. The principal product, therefore, is crushed stone. It has been used to some extent, also, as paving blocks, but these are rather difficult to prepare, since trap very seldom shows any capacity for parting comparable to the rift and grain structures of granites. As a building stone it finds very little application, probably on account of its somber color. The expense of cutting and dressing trap is also an obstacle to its employment for building or ornamental purposes.

The trap quarried in New York State is properly a diabase. Its mineral composition varies somewhat in the different occurrences, but the main ingredients are plagioclase, feldspar and pyroxene, with more or less of amphibole, olivine, magnetite and sometimes biotite. The texture is characteristic, for the feldspar forms lath-shaped crystals which interlace and inclose the pyroxene and other ingredients in the meshes, and it is this firmly knit fabric which gives the stone the qualities of strength and toughness.

The largest occurrence of trap in New York is represented by the Palisades of the Hudson and the continuation of the same intrusion which extends southward through New Jersey onto Staten Island and is also encountered in the interior of Rockland county. The Palisades are the exposed edge of a sill or sheet of diabase that is intruded between shales and sandstones of Triassic age. The sheet is several hundred feet thick, in places nearly 1000 feet, and in general seems to follow the bedding planes of the sedimentary strata which dip to the west and northwest at an angle of from 5° to 15°. The outcrop is narrow, seldom over a mile, and in places is limited to a single steep escarpment. The principal quarries are near Nyack and Haverstraw at the base of the cliffs. Other quarries have been opened near Suffern, Rockland county, on an isolated intrusion, and also near Port Richmond, Staten Island, at the southern end of the Palisades sill.

Trap occurs in numerous places in the Adirondacks, but mostly as narrow dikes. It is especially common in Essex and Clinton counties where there are many thousands of dikes that range from a few inches to 20 or 30 feet thick. On the southern border of the region are a few dikes of notable size, such as that in the town of Greenfield, Saratoga county, and at Little Falls in the Mohawk valley. A quarry has been opened in the Greenfield occurrence for the supply of crushed stone.

For many years the leading trap quarries have been those situated along the river front of the Palisades from Haverstraw to Nyack. Their output during the height of the industry amounted to over a million cubic yards annually. Since 1910 negotiations have been in progress for the acquisition of the quarry properties in connection with the Palisades Interstate Park which is designed to include the lands lying between the river line and the top of the ridge. The completion of the plans for the park is now in prospect and it is unlikely that quarry operations at the present sites will last much longer. The quarries of the Rockland Lake Trap Co. and of the Manhattan Trap Rock Co. have already been closed. The final extinction of the industry will involve an increase in the price of trap in the lower Hudson district, inasmuch as there is no other place where it can be obtained so conveniently and at so low cost.

The output of trap in 1915 amounted to 683,700 cubic yards valued at $550,960. Of this quantity 409,100 cubic yards valued at $331,280 consisted of crushed stone for roads. The figures showed a decrease in comparison with the totals for 1914 which were reported as 975,000 cubic yards valued at $770,000.

TALC

The dulness in the talc trade which prevailed during the later months of 1914 continued into the following year and caused some reduction in the mining and milling operations, although there were no producers that withdrew from business. The depression was caused more particularly by the curtailment of demand in the paper industry which supplies the principal outlet for the local product. The market showed some improvement during the last six months of the year, when paper makers began to experience difficulty in filling their requirements of white clay which had been obtained, hitherto, from England and Germany and consequently turned to talc as a substitute.

The output for the year amounted to 69,514 short tons valued at $576,643, or a little less than in 1914, but fully up to the average

of earlier years. The list of active firms included the Ontario Talc Co., the International Pulp Co. and the Uniform Fibrous Talc Co. in the Gouverneur district and the St Lawrence Talc Co. of Natural Bridge.

There was a cessation of exploratory work during the year on the part of development enterprises and no new additions to the list of producers is in prospect for the current season.

The talc industry occupies a position of considerable economic importance in the limited field in which it is carried on. The labor item is the principal element of cost in production, and a large quota of the local population find employment in one or another of the branches of the industry. The mining operations of themselves are not so extensive in their requirements, but in addition there is the milling which involves a process of gradual reduction continued over several hours and the haulage necessitated by the fact that some of the mines are situated at a distance from the railroad which serves the district.

The Gouverneur talc began to enter the market about 1880. Shipments of some importance were made before that date, but from that time they have been continuous and in large volume. Since 1900 the average annual output has exceeded 60,000 tons. Altogether the production has amounted to about 1,700,000 tons valued at $15,000,000.

Production of talc in New York

YEAR	SHORT TONS	VALUE	YEAR	SHORT TONS	VALUE
1883	6 000	$75 000	1900	63 500	$499 500
1884	10 000	110 000	1901	62 200	483 600
1885	10 000	110 000	1902	71 100	615 350
1886	12 000	125 000	1903	60 230	421 600
1887	15 000	160 000	1904	65 000	455 000
1888	20 000	210 000	1905	67 000	519 250
1889	23 476	244 170	1906	64 200	541 600
1890	41 354	389 196	1907	59 000	501 500
1891	53 054	493 068	1908	70 739	697 390
1892	41 925	472 485	1909	50 000	450 000
1893	36 500	337 625	1910	65 000	552 500
1894	50 500	454 500	1911	65 000	552 500
1895	40 000	320 000	1912	61 619	511 437
1896	46 089	399 443	1913	63 000	551 250
1897	57 009	396 936	1914	74 075	671 286
1898	54 356	411 430	1915	69 514	576 643
1899	54 655	438 150			

ZINC

The progress of the interesting developments in zinc mining at Edwards, St Lawrence county, has been described in previous issues of this report, and a brief account of the ore occurrences and their geological surroundings was included in the issue for 1912 (Museum Bulletin 166). During the past year productive operations were begun, resulting in the first shipments of zinc ores on a commercial scale that have been made by any enterprise within the State.

The source of the production, which amounted to a few thousand tons of blende concentrates, was the mine of the Northern Ore Co., situated just outside the village of Edwards on the road leading to Trout lake. The property, with showings of ore at the surface but unprospected at the time, was acquired by the company over ten years ago. Owing to the unusual character of the deposits, scarcely comparable in their geological relations to any other bodies of zinc ores now mined in this country, the conduct of the early exploratory work could hardly be guided by experience with similar ones elsewhere, and it was essential to adopt a conservative policy in the development and equipment of the property. In the past year the workings have been extended to a depth of about 500 feet, following a lens of ore that is inclined 25°–60° from the horizontal. There are no indications on the lowest level of any change in the geological conditions which might lead to the interruption of the ore-bearing ground and the discontinuance of the deposits; on the contrary, the conditions seem favorable to the extension of the ore beyond the depths attained up to the present time.

So far the Northern Ore Co. has worked only one shaft, near the south line of the Edwards property, that follows a vein or lens of solid blende and pyrite, about 5 feet thick at the surface, swelling to 14 feet at the 150 foot level and thinning again where seen in the 300 and 400 foot levels. The longest levels are about 600 feet on the strike of the ore. The ore body to the south of the shaft curves around in a broad arc, so that at the extreme end of the working stopes the direction of dip is southwest or at right angles to that of the shaft itself. Swells and pinches occur frequently, and stringers of ore occasionally branch off from the main body. There is much resemblance in the shape of the deposit to the form assumed by some of the magnetites in the harder crystalline rocks of the Adirondacks. A second lens of ore shows at the surface to the

west of the shaft in the hanging wall and is tapped underground by cross cuts from the main levels. This body is smaller, about 4 feet thick at the surface and 150 feet wide in the drift at the 200 foot level. The ore is intersected by small slips or faults. One fault is seen on the second level at the south end where it is accompanied by a sheeted zone of limestone that apparently terminates the ore; it lies near the edge of the limestone and is concealed at the surface by the alluvial beds that floor the adjacent valley. Evidences of faulting are found on the surface northeast of the shaft in the occurrence of a fracture zone which cuts across the bedding of the limestones; the zone is 3 feet or more wide.

About 800 feet northeast of the working shaft, on the opposite side of the limestone ridge, an outcropping lens of ore has been prospected at the surface and for some distance underground, but has not been actively worked. The sulphides here occur in bunches, bands and as disseminations, intermixed with secondary silicates and limestone. The shape of the deposit is like a thick lens or shoot, but is less well defined than the bodies previously described. There is evidence of crushing and differential movement within the ore, which may be partially accounted for perhaps by the greater amount of silicates that have undergone hydration and swelling. The ore shades away at the edges into the country limestone.

The ore from the property is rich as compared with the usual grades of zinc blende that are now mined in this country. The product of the present openings is a mixture of sphalerite and pyrite with variable but usually small amounts of gangue. The sphalerite predominates over pyrite, but samples may be gathered which show the two minerals in nearly equal proportions. The texture is very compact, with no vugs or openings of any size, the grains being firmly interlocked. The individual particles have rounded and irregular outlines. The grain varies from rather coarse to fine, the coarser ore being found in the larger and richer bodies; the disseminated sulphides are usually finely divided. The ore now mined probably averages 25 per cent or more in zinc. The sphalerite is dark, almost opaque, as seen in the hand specimen, indicative of considerable combined iron, which is confirmed by its magnetic permeability. In one part of the Edwards mine, ore of light brown color has been uncovered. Galena occurs in small amount, less than 1 per cent, but is seldom discernible in the hand specimen. The presence of barite in the gangue was determined from specimens taken by the writer several years ago from the outcrop. It is of subordinate importance. The principal ingredients

of the gangue are dolomite and lime-magnesia silicates, with serpentine and talc as alteration products of the latter.

The Edwards mine has a peculiar place in the zinc-mining industry at the present time, being the only representative of its type in the country. Similar deposits of sphalerite occur in the Precambric limestones of eastern Canada and have contributed small quantities of ore for smelting, but so far as known this is the only active enterprise based on such deposits within the United States.

The operations of the Northern Ore Co. are in charge of Justice Grugan as manager.

The belt of crystalline limestones in which the deposits lie stretches to the southwest of Edwards in unbroken continuity into the town of Fowler and is traceable beyond Sylvia lake, which occupies a bowl-shaped depression in the same limestones. Prospecting has been active in the district during the last year or two, and many new localities for zinc ores have been discovered.

Between Edwards and Fullerville there are showings of blende on the farm of Woodcock Brothers, south of the highway, in a ledge of limestone that contains bands of white quartz. Where uncovered the blende is seen in streaks and disseminations that follow the strike of the wall rock and occupy a zone several feet wide. The outcrop is marked by rusty, hornblende material which, however, is of slight depth. The gneiss that limits the limestone belt occurs within 50 feet of the ore.

The McGill farm, next on the southwest, has a prospect that shows 2 or 3 feet of light brown blende, free of pyrite. The hanging side of the deposit, in contact with the limestone, shows differential movements, with the formation of slip-fiber asbestos.

On the H. Webb place the ore appears at approximately the same horizon, close to the gneiss, along a ridge of limestone that follows the general strike of the beds. It has been uncovered in several places which seem to mark a more or less well-defined zone of mineralization carrying sulphides in bands and as disseminated grains. Shallow holes have been blasted into the ridge, following the dip of the ore, which is 40° to 60° northwest. The richer bands are fairly well marked on the borders and attain a thickness of 6 to 8 feet. Altogether the ore outcrops and prospects cover a distance of 800 feet along the face of the ridge. The blende is light in color and is admixed with less than the usual amount of pyrite. A. J. Moore of Edwards has explored this part of the district.

On the McGill farm farther southwest is a prospect with some showings of blende in scattered bunches and disseminations. The

opening is close by the road, somewhat distant from the limiting ridges of gneiss. Messrs Finch and Potter of Gouverneur have a lease of the property.

The occurrence of zinc on the Balmat, Streeter and Tamlin places east of Sylvia lake has been known for some time. The Balmat property was prospected over 75 years ago for lead, which is found as a larger ingredient of the ore than elsewhere in the district. The presence of so much zinc, however, proved an obstacle to its utilization, which apparently could not be overcome by the methods then employed, and little ore was mined. The property is now owned by the Northern Ore Co. which is holding it as a reserve for the future. The Streeter property has a good showing of ore which forms a well-defined band, much like the deposit now being worked at Edwards.

In the vicinity of the Balmat property a deposit of zinc has been uncovered by the Dominion Company in the extension of an old shaft which was once worked for iron ore for use in the furnace at Fullerville, now dismantled and in decay. The iron is present as hematite of soft, paintlike texture, which deeper down changes to a harder siliceous ore in which sulphides are found. It would appear probable that the hematite is simply the oxidized outcrop of the sulphides. The latter occur in finely divided particles, with a quartz gangue. The deposit seems to be a pipe or shoot, rather than a lens.

Northeast of Sylvia lake, between there and the hamlet of Little York, are several small showings of sphalerite and pyrite, mostly of disseminated character. Some of them are on the Austin place. The limestone of this section of the district is characterized by a larger proportion of impurities than is usually found; vitreous quartz, chert and serpentine make up a large part of the mass. On the weathered surface the limestone is ribbed by the quartz which has a tendency to aggregate in parallel bands that are brought into prominence by the solution of the included carbonates.

A showing of blende is found on the cemetery lot, near Balmat corners, just off the Gouverneur sheet. It has been prospected by Arthur C. Scott of Fowler and occurs on the east side of a limestone ridge that parallels the road. The limestone is seamed with white quartz which stands out in prominent ledges and also contains much serpentine and talc. The ore forms a band that is exposed by the opening only for 10 or 12 feet on its course along the hill, with a stringer making off at right angles into the hanging wall.

The blende and pyrite are segregated, instead of being intergrown as in most instances, while they are accompanied by secondary calcite and other unusual features.

J. C. Finch reports to the writer the occurrence of zinc on the west branch of the Oswegatchie, near the falls, about 3 miles above Fullerville. This locality is rather remote from the main district and indicates the extension of the limestone farther south than has been indicated on the maps. It appears quite certain that a narrow tongue of the limestone extends south on the east side of the West Branch at least to the locality named, which is just off the limits of the Gouverneur quadrangle.

The Davis farm, northwest of Pleasant Valley school, is one of the new localities for blende that has been under prospect. It is held under lease by Gouverneur parties, with B. J. Hatmaker in charge. The ore occurs in disseminated grains within a zone of impure limestone, but had not been explored to any extent at the time of the writer's visit in August 1916.

Across the Oswegatchie river from the mine of the Uniform Fibrous Talc Co. is a ridge of impure limestone in which an old talc shaft was sunk years ago. Nearby an opening shows 3 to 4 feet of fairly rich blende, with some pyrite, having a mottled appearance from inclusions of carbonates. The ore appears to run about north and south and dip steeply to the west, but it has not been explored sufficiently to reveal fully the extent and attitude of the body. Another outcrop is found on the south side of the ridge, nearly in line with the first. The locality is on the Freeman farm now leased by the Dominion Company.

Nature of ore occurrence. Two types of ore bodies may be distinguished on the basis of the methods of aggregation. In the one type the zinc and iron sulphides form a well-defined band, shoot or lens within the limestone. The contact is sharp and shows little evidence of a true gradation between the ore and wall rock, although if the two are frozen the ore may send out stringers from the main body for a little distance into the limestone. In this type, however, it is rare to find both foot and hanging wall tightly cemented; more often the ore breaks clean from one wall and is separated from the limestone by a gouge of talcose decomposition products. This type of deposit averages high in metallic content, the blende and pyrite together forming more than 50 per cent of the mass, and specimens may be found that are practically solid sulphides. The visible gangue minerals are chiefly serpentine and talc which occur

as nodular particles surrounded by the sulphides, and are of the same nature as the silicate inclusions in the limestones. It is rather evident that they were formed before the ore, representing the unreplaced matter in the process of mineralization.

In the second type the sulphides are disseminated through the limestone, usually within a more or less restricted zone which itself constitutes a band or lens that on the borders shades off into the country limestones. The percentage of sulphides is much smaller than in the other type, in most examples constituting but a small per cent of the whole mass. The individual grains of pyrite and blende are surrounded by those of dolomite; and silicate minerals abound, often constituting nodular bodies that measure several inches to a foot in diameter. The size of the metallic particles averages much smaller than it does in the richer ores illustrated by the first type.

As to the general distribution of the ores in the limestone it can be said that they favor the border zone more often than otherwise. Although some showings have been found within the middle of the belt, they are mainly of the disseminated form of occurrence which has not yet been proved to be of commercial value.

It is also noticeable that the limestone in the vicinity of the deposits is always impure, owing to the presence of silicates. In their original form these consisted of tremolite and diopside but they are now mostly altered to serpentine and talc. The association of the ores with the silicated layers is too constant to be merely accidental, but points to a genetic relationship which need not be explained, however, in this place. The vicinity of the talc mines offers favorable ground for prospecting for zinc. The fact that the sulphides have not been penetrated in the mines themselves is to be explained by the fact that the openings are carried always within the talc, never reaching out into the country rock in the ordinary course of operations. The writer discovered some good specimens of zinc blende in the dump of one of the mines in which exploratory work for the purpose of finding a possible continuation of the talc had been carried into the overlying limestone.

Another suggestion for the guidance of prospecting operations is prompted by the occurrence of the hematite deposits which at one time were actively worked for the supply of the Fullerville furnace. The hematite, not unlikely, may prove to be the gossan or oxidized outcrop of the sulphides, as was suggested by the writer in an

earlier account of the deposits. This has been actually found to be the condition in the old iron mine on the Dominion Company's property near Sylvia lake. There the unaltered zinc and iron sulphides were encountered at less than 100 feet from the surface, although the material above was a soft hematite. There is no certainty of course that the same result would be obtained by deepening the other iron-ore pits, but from a prospecting standpoint the localities seem to be worthy of consideration.

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Appendix 3

Entomology

Museum Bulletin 186

186 31st Report of the State Entomologist 1915

New York State Museum Bulletin

Entered as second-class matter November 27, 1915, at the Post Office at Albany, New York, under the act of August 24, 1912

Published monthly by The University of the State of New York

No. 186 ALBANY, N. Y. June 1, 1916

The University of the State of New York

New York State Museum

John M. Clarke, Director
Ephraim Porter Felt, State Entomologist

31st REPORT OF THE STATE ENTOMOLOGIST

ON

INJURIOUS AND OTHER INSECTS

OF THE

STATE OF NEW YORK

1915

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The University of the State of New York
Science Department, December 18, 1915

Dr John H. Finley
President of the University

SIR: I have the honor to transmit herewith and to recommend for publication as a bulletin of the State Museum, the annual report of the State Entomologist for the year ending September 30, 1915.

Very respectfully
JOHN M. CLARKE
Director

THE UNIVERSITY OF THE STATE OF NEW YORK
OFFICE OF THE PRESIDENT

Approved for publication this 3d day of January 1916

John H Finley

President of the University

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31st REPORT OF THE STATE ENTOMOLOGIST 1915

Dr John M. Clarke, Director of the State Museum

I have the honor to present herewith my report on the injurious and other insects of the State of New York for the year ending September 30, 1915.

The depredations of the apple tent caterpillar and the forest tent caterpillar, so evident the last two years, were continued the past season, though severely infested localities were more restricted than in earlier years. Popular warning notices were sent early to the press. On Long Island in particular, a power spraying outfit was used most successfully, though the large areas of oak infested made it impossible to cover all satisfactorily with the equipment available.

There was an unusual and entirely unexpected outbreak of the cherry leaf beetle, Galerucella cavicollis Lec., a small, reddish brown insect which appeared in immense numbers in widely scattered localities and caused considerable apprehension because of its feeding upon cherry and peach tree foliage, though in most instances the damage was comparatively insignificant.

Oil injuries. The unfortunate developments following the application of oils or oily compounds to the bark of deciduous trees has again come to our attention, and in one locality was followed by serious injury to forest trees. Experimental tests with this compound upon small forest trees, under normal conditions, resulted in the death, within six months, of six out of ten, while the remaining four showed evidence of injury which may be followed by death another season. Details of this work are given in the body of the report.

Fruit tree insects. Practical work with the codling moth was conducted the past season in cooperation with the bureaus of farmers' institutes and of horticulture of the State Department of Agriculture and the Monroe County Farm Bureau. These studies, conducted in three commercial orchards in western New York, showed first of all a marked discrepancy between the habits of the insect in portions of the western part of the State, as compared with the Hudson valley. The cool evening temperatures prevailing near Lake Ontario at about the time the moths appear result, in some seasons at least, in a delayed deposition of eggs and a very high percentage of side injury caused by the young codling moth larva entering the smooth surface of the fruit and then, in many instances, migrating to the blossom end. This characteristic blemish affected 20 per cent or more of the yield in some cases. The data obtained emphasize the great importance of the spraying given just after the blossoms fall, and also the advisability in sections where this injury is prevalent, of making annual applications whether the trees be fruiting or not. Furthermore, the second spraying ordinarily advised for the codling moth, namely about two weeks after the first, would probably be more effective in reducing this side injury if it were made the latter part of June. The general prevalence of apple scab in this section amply justifies three sprayings after the blossoms drop, even though the latter two are not necessary for the control of insect pests. A detailed account of the work is given in the body of the report.

Leaf roller. Investigations made in connection with the above-named codling moth work showed this insect to be generally distributed and frequently very abundant in apple orchards of western New York. Furthermore, the data obtained when classifying the fruit for codling moth work indicated very little reduction in leaf roller injury as a result of any of the poisoned applications made after the blossoms fell. The injury by this insect in the Hudson valley is much less and, generally speaking, is almost negligible. An exhaustive study of this species is being made by our colleague, Prof. G. W. Herrick, and there is therefore no necessity for giving more attention to this species at the present time.

Green fruit worm. These characteristic leaf and small fruit eaters were somewhat abundant in western New York and less so in Hudson valley orchards, the damage apparently not equaling that caused by the leaf rollers.

San José scale has been less abundant in some Hudson valley orchards than in earlier years, though this does not appear to be

equally true of the western part of the State. Examinations in several infested and unsprayed orchards in the town of Schodack show a decrease in the infestation compared with that of two years ago. The reduction is probably attributable in large measure to the activities of various small parasites. The condition of most of these infested trees, however, is not entirely satisfactory, and although the damage resulting from scale infestation is much less, we do not consider that this justifies the abandonment of dormant applications for the control of this pest.

Apple maggot, generally known in New England as the railroad worm on account of the irregular, brown, sometimes rotting channels caused by the maggots in the flesh or pulp of the fruit, is becoming locally abundant in some fruit-growing sections in the Hudson valley. The attention of the Entomologist was called to some very badly infested trees this season and it is evident, should this condition continue, that active, repressive measures must be adopted for the control of the pest.

Red bugs. The two red bugs, as shown by more extended observations the past season, are both widely distributed in the Hudson valley, and where unchecked have frequently seriously damaged the apple crop. The lined red bug appears to be more numerous though the other species is sometimes abundant. Practical work during the past summer has demonstrated the efficacy of a tobacco application just before the blossoms open.

Pear thrips. The erratic and sometimes complete destruction of the pear crop by this new pest has continued here and there in the Hudson valley. It was especially serious the past season because an early and extremely warm period caught many growers unaware and gave the thrips an opportunity to enter the blossoms. This was followed by comparatively cool weather accompanied by a slow development of the leaves and flowers, a condition favorable for severe damage by insects which might have gained entrance to the buds during the warm weather. Observations show that this attack may be very sudden and trees apparently free from thrips one day may be infested by large numbers the next, this even occurring in orchards where the pest was practically unknown the preceding season.

Pear psylla. Serious injury by this insect has prevailed in some Hudson valley orchards, though the outbreaks were usually very limited and were, as shown by observations of the preceding year, frequently closely related to unusually favorable winter shelters, such as nearby brush heaps, fences or stone walls and their accompanying weedy growths.

The sinuate pear borer, another European insect which became established in New Jersey some years ago, is extending its range slowly in New York State and is already known in several localities. It is an extremely dangerous pest owing to its insidious method of work, because the larvae make numerous serpentine, interlacing galleries in the inner bark and outer sapwood, thus speedily destroying limbs or entire trees before there are marked, outward signs of the borer's presence.

Gipsy moth. An examination of conditions obtaining at Mount Kisco where an infestation of several years' standing was discovered in 1914, shows that very satisfactory work has been done in the control of the pest. The infested areas have been well cleaned, banded with tanglefoot and sprayed, and the outlying, unsprayed area banded with burlap for the purpose of catching any possible stray caterpillars. The great reduction in the infestation, as compared with conditions obtaining last year, is very gratifying, and if the work is continued along present lines the probabilities are excellent of eliminating this local infestation by an insect known to be a serious enemy of both orchard and forest trees.

Grass and grain pests. The extended grasshopper devastations of last year on the borders of the Adirondacks, especially in portions of Fulton, Saratoga and Warren counties, were continued, though the insects were present in much smaller numbers, especially in Fulton county where poisoned bait was used very effectively the preceding season. The Entomologist, cooperating with the State Department of Agriculture and the Saratoga County Farm Bureau, conducted a series of experiments for the destruction of young grasshoppers. It was found that while the poisoned, fruit-flavored bait, frequently known as the Kansas bait, would kill many of the grasshoppers, especially in sections where vegetation was sparse, that a sweetened solution of sodium arsenite was most effective in destroying young grasshoppers in fields where there was considerable vegetation, particularly in clover seedings. The work of the past two seasons has demonstrated beyond all question the practicability of controlling outbreaks of this character, even on individual farms, though cooperation in badly infested areas is extremely desirable. The details of this work are given on following pages.

The white grub outbreak of last season, predicted by the Entomologist the preceding fall and spring, was very serious in southern Rensselaer and northern Columbia counties in particular, though the damage was mitigated to a considerable extent by an unusually copious and well-distributed rainfall during the summer months.

Last fall and early in the spring the Entomologist sent out popular notices regarding these insects, giving directions for the location of badly infested areas and advising certain preventive measures. In spite of these warnings numerous farmers suffered unnecessary losses, either by allowing badly infested land to remain unplowed, or by planting potatoes, corn and other susceptible crops upon recently turned and seriously infested sod. The three-year life cycle of these insects makes it comparatively easy for a farmer to judge the probabilities of damage a year or two in advance.

Depredations by grass webworms have continued in Dutchess county, in one case a five acre field of corn near Pine Plains being destroyed by the insects. The work of these pests, as in the case of white grubs, can be avoided to a large extent by refraining from planting badly infested sod to susceptible crops such as corn. An effort has been made to interest several persons in the practical control of these insects and it is possible that grasslands can be effectively freed from the pests at a very moderate cost.

Shade tree insects. Injuries by the elm leaf beetle have not been particularly severe the past season, due in part presumably to low temperatures prevailing in June and thus delaying egg deposition, and also probably to the abundant rainfall which has enabled the trees to withstand successfully a considerable amount of leaf injury. Many of the insects completed their transformations successfully, and with favorable climatic conditions another season severe damage may result in localities where the trees suffered but little the past summer.

Other rather common shade tree pests such as the white-marked tussock moth, the false maple scale and the cottony maple scale, have attracted comparatively little attention the past season.

Forest tree pests. There has been continued injury by the hickory bark beetle in the vicinity of New York City and in other sections of the State though the insects do not appear to be so abundant and destructive as in earlier years. The general interest in the protection of forest trees, especially in the vicinity of New York City, has resulted in the cutting out of many dead and dying trees which has undoubtedly had a material influence in reducing the numbers of the pest. In this connection we have been able to rear large series of secondary forms occurring in dying and dead hickory trees.

The two-lined chestnut borer is continuing its nefarious work and destroying groups of oaks, especially in regions about New York City. Here, likewise, the prompt removal and destruction of infested trees is of considerable value in checking the pest.

The recently established bayonet or post-horn pine borer, an introduction from Europe, has come to our attention from several localities and bids fair to develop, unless kept under rigid control, into a serious enemy of our native pines.

Another pine twig borer, Dioryctria abietella Zinck., has been found working in the buds of Austrian pine at Rochester. It tunnels the young shoots and in some instances produces a deformation very similar to the species named above.

Periodical cicada. A scattering infestation of this interesting species was reported the past season from here and there in the Hudson valley, indicating a somewhat general and sparse distribution in this region, of a brood almost unknown heretofore north of the immediate vicinity of New York City.

Flies and mosquitoes. Interest in the control of the house fly and its associates has continued. The Entomologist has complied with a number of requests for information in regard to these insects and their control, a matter which has also received some attention through the State Department of Health.

The control of mosquitoes has been undertaken in cooperation with several local improvement associations, the most important being that in conjunction with the Sodus Point Improvement Association. The conditions in this locality are somewhat unusual, in that there are large areas of practically lake level swamps in the immediate vicinity of a summer resort, consequently draining or filling were out of the question, the former being impossible and the latter impractical on account of the great expense involved. Another peculiar feature was the occurrence of considerable areas of floating or nearly floating cat-tails and, as subsequent investigations showed, adapted to the breeding requirements of the irritating mosquito, a species remarkable because the larvae depend for their air supply upon that contained in the roots of various aquatic plants. The Entomologist advised the employment of a reliable person to work under his direction for the purpose of ascertaining the most important breeding places and their treatment with oil before there was an opportunity for the wrigglers to mature. Incidentally it was planned to make observations upon the mosquito fauna of the region for the reason that such exact biological data should be made the basis of future work. The results were very satisfactory from both the practical and scientific standpoint and are discussed in some detail on the following pages.

Gall midges. The past season has been marked by the discovery of the Chrysanthemum midge, Diarthronomyia hypogaea

H.Lw., in widely separated localities in the country. These European midges deposit their eggs upon the young growth and when abundant may produce such marked deformations as to render the plants practically valueless. Studies have been made of this insect and its habits and an extended account is given in the body of the report.

Our studies of the gall midges have been continued and a number of new species, mostly reared, and several new genera described. One of the more important papers relating to this group and published during the past year, appeared in the Proceedings of the United States National Museum and describes a number of exotic species and contains a revised tabulation for the separation of the genera in the Asphondyliariae.

Lectures. The Entomologist has delivered a number of lectures on insects, mostly economic species, before various agricultural and horticultural gatherings, some of them being in cooperation with the bureau of farmers' institutes or county farm bureau agents. Several lectures have also been given under the auspices of local improvement associations.

Publications. A number of brief, popular accounts regarding such common pests as the apple and forest tent caterpillars, pear thrips, white grubs, etc., have been widely circulated through the press. A list of the more important publications of the year is given in this report.

Faunal studies. The investigations along these lines have been continued and the manuscript list of the insects of the Adirondack region, based mostly upon material in the State collection, is nearly ready for publication. This list is a growing one, additions being constantly made thereto in connection with other work carried on within the limits of this faunal area, such as the study of grasshoppers noted above.

Collections. The assembling and preparation of the enlarged exhibit of insects has required much time and necessarily prevented very desirable work in the arrangement and classification of the reference collections. Additions to these latter are constantly being made, especially of specimens representing the early stages and work of various injurious forms, since biological material of this character greatly facilitates identification of the different insects and is indispensable in a well-prepared exhibit illustrating the life histories of different species. The State collection now contains a large amount of material which is invaluable because of the associated data. Numerous microscopic preparations of smaller insects have been made and incorporated in the collections as in earlier years.

A very advantageous exchange (the species are listed elsewhere) has been made with Dr Nathan Banks of East Falls Church, Virginia, the State becoming the possessor of a number of species determined by this specialist in Diptera. A similar exchange has also been made with Mr R. R. Parker, now of Montana, who has made a special study of the very difficult flesh flies or Sarcophagidae. The species acquired from this student are listed with the other accessions.

The need of additional boxes or trays referred to in previous reports still exists. The wooden cases containing the insect collections should be replaced by steel cabinets and more provided to accommodate the extra boxes and trays required. No adequate provision has as yet been made for the constantly increasing biological material, which is also true of the large number of microscopic slides, many of them containing types of species and genera and therefore impossible of duplication. A metallic filing case for the collection of negatives and photographs illustrating insects or their work is also greatly needed.

Nursery inspection. The nursery inspection work of the State Department of Agriculture has resulted in numerous specimens representing any stage in insect development, some in very poor condition being submitted to the Entomologist for identification. As such material may originate in a foreign country, determinations of this character are laborious and require for their successful prosecution a large collection and an excellent library of both domestic and foreign works. The correct identification of such material is very important, since the disposal of entire shipments of nursery stock must depend in considerable measure upon the character of the infestation.

General. The work of the office has been materially aided as in past years, by the identification of a number of species through the courtesy of Dr L. O. Howard, chief of the bureau of entomology, United States Department of Agriculture, and his associates. There has been, as already stated, very effective cooperation with the State Department of Agriculture, a number of county farm bureaus and other public welfare agencies in the State. A number of correspondents have donated valuable specimens and many have rendered efficient service by transmitting local data respecting various insects. It is a pleasure to note that there has been, as in the past, a most helpful cooperation on the part of all interested in the work of the office.

Respectfully submitted

EPHRAIM PORTER FELT

State Entomologist

October 15, 1915

INJURIOUS INSECTS

CODLING MOTH

Carpocapsa pomonella Linn.

Serious and repeated injury in the western part of the State by what was supposed to be the work of the second brood of the codling moth, resulted in the planning of a series of experiments in connection with field observations, to ascertain if there was not some way of lessening the damage. The work was undertaken in cooperation with the bureaus of farmers' institutes and of horticulture of the State Department of Agriculture, and also with the Monroe County Farm Bureau. The orchards selected for the experiments were located through the courtesy of Messrs A. B. Buchholz of Albion, and L. F. Strickland of Lockport, both agents of the State Department of Agriculture, and of Mr L. A. Toan of Rochester, manager of the Monroe County Farm Bureau. It was our aim to secure orchards in a good horticultural condition, which had been sprayed regularly and thoroughly for a series of years and which were also in sections where the codling moth was known to be injurious. Furthermore, in order to secure satisfactory data it was necessary to take orchards which promised a fairly good and uniform crop; otherwise comparisons are apt to be confusing.

Satisfactory orchards were located in Albion, Monroe and Niagara counties, and through the courtesy and cooperation of Messrs J. A. Talbot of Spencerport, H. E. Wellman of Kendall, and W. H. Cowper & Son of Newfane, every facility was placed at our disposal, these gentlemen agreeing to spray according to the plan described in detail below. In each case the men and the equipment on the place were used, the Entomologist supervising the operations. There were twenty experimental trees in each orchard, some bearing as high as eleven barrels, so that the manual labor involved in the actual sorting and classification of the yield was by no means small and acknowledgments are due Messrs Toan, Buchholz and Strickland, especially the last named, since he was personally responsible for the classification of the wormy fruit in all the orchards, for the material assistance they rendered in this laborious part of the undertaking.

Life history and habits. Before giving the details of the experimental work, it may be well to outline the life history of the pest, since a knowledge of its habits is essential to satisfactory control work. The codling moth or apple worm winters in a tough, silken

cocoon usually located in an oval cell under the rough bark of trees. The caterpillars transform to brown, apparently lifeless pupae in late April and early May and the moths commence to emerge and continue to appear throughout the greater part of June. Cool evenings, that is, a temperature below 60°, may delay egg laying considerably. The minute, whitish eggs are deposited largely on the leaves, though under certain conditions, as shown by our observations of last June and July, they may be more abundant on the young fruit. The eggs hatch in about a week and consequently the young apple worms of the first brood may be entering the fruit from early in June, approximately three weeks after the blossoms fall, to the end of the month or even later. Some of these young caterpillars, especially those hatching from late deposited eggs, have the habit of gnawing a small hole in the side of the fruit, excavating a circular gallery with a radius of approximately one-sixteenth of an inch and then deserting this cavity and entering at the blossom end. This appears particularly likely to occur in the western part of the State during late June and early July and is there generally known as " side injury " (see plate 1). The caterpillars require about four weeks to complete their growth, at which time they desert the fruit, wander to a sheltered place, spin a cocoon, transform to pupae and in about two weeks, namely the last of July or early in August, another brood of moths may appear. These in turn deposit eggs which hatch in due time and the young larvae enter the side of the fruit, especially where two apples touch or a leaf hangs against the apple, as well as at the blossom end. Two broods appear to be the rule in the northern fruit-growing section of the United States, though some investigators claim a third in the southwest.

EXPERIMENTAL WORK

Newfane orchard

Three plots were located in the orchard of W. H. Cowper & Son of Newfane, the farm being managed by E. G. Cowper. The orchard borders upon the Lockport-Olcott trolley line and is composed of Greenings about 35 years old, set approximately 27 by 30 feet apart and about 15 feet high. The orchard is cultivated and is mostly in a very good condition, though the trees are a little close for thoroughly satisfactory spraying. Mr Cowper states that this orchard has received three sprayings annually for the last seven years, the first being the dormant spray, the second just as the blossoms were falling, and the third during the fourth week in July or the first week in August, the two latter treatments, except last year, being

restricted to fruiting trees. Prior to the above-mentioned period there was no spraying so far as we have been able to learn. There was a fairly heavy and uniform bloom on the selected trees. The plots were laid out so far as practical on the basis of 42 trees, 6 one way and 7 the other, the 6 central trees being the ones from which the data were secured. Special care was exercised to obtain so far as possible a uniform bloom.

Plot 1 was located 2 trees north of the Lockport-Olcott trolley line and 2 trees east of a temporary roadway across the end of the orchard.

Plot 2 was 7 trees north of the trolley line and 2 trees east of the roadway.

Plot 3 was 12 trees north of the trolley line and 1 tree east of the roadway.

The check trees were 12 trees north of the trolley line and 9 trees east of the roadway.

This arrangement, a modification of the typical plan outlined above, was rendered necessary by vagaries in blooming and plots 1, 2 and 3 were therefore separated from each other by but 3 instead of 4 trees.

A period of unusually cool weather occurred at the time of blooming and as a consequence the dropping of the petals was greatly delayed. The first application of poison was made May 19th, the day being cool and clear. Only about one-third of the blossoms had fallen, though the stamens had mostly burst. The petals were dropping very freely at the time of spraying. Two pounds of Corona dry arsenate of lead and $2\frac{1}{2}$ gallons of Grasselli's 33° lime-sulphur wash were used to each 100 gallons of spray. A 33° Brown angle disk nozzle was employed together with a rather coarse disk and 160 pounds pressure. The spraying was done entirely from the top of the tank, the platform being about 7 feet high, an 8-foot extension being employed. About 6 gallons (6.4 gallons was the average for 19 trees) of the spray were applied to each tree. The northeast corner of tree A was not thoroughly sprayed though the others were covered in a fairly satisfactory manner.

The average time of spraying 3 moderate sized trees was $2\frac{2}{3}$ minutes. The black spray was easily seen on the outside of the base of the white stamens and a little on the inside and even on the pistil, though uniform penetration of the lower calyx cavity did not occur. There appears to be ample poison on the stamen bars to kill the young larvae.

Some old, partly rotten apples were to be seen under trees here and there in the orchard, but codling moth larvae were not excessively abundant under the bark of such trees. One pupa was found on a tree at the base of which was a pile of old apples.

The second spray was applied on the afternoon of June 8th to plots 2 and 3, the treatment in this instance being restricted to the 6 experimental trees of each plot, there being no attempt to include the barrier trees in this application. The work was started at 4.55 p.m., the afternoon being clear, mild and with a light breeze. The spraying was completed at 5.10 and approximately 7 gallons were used to each tree. Engine troubles delayed the work somewhat. Two codling moth larvae just ready to pupate were found in the orchard.

Leaf rollers were somewhat common, a few pupae and full-grown larvae being seen. Young tussock moth larvae were also hatching in small numbers, though the latter were not abundant enough to be important factors.

Numerous eggs and recently hatched larvae were found July 13th on certain Baldwin apple trees. Some of the eggs had just been laid and were white, others were in the red stage, a few in the black stage and a number of egg shells were also seen. There were 2 or 3 and, in a few cases, 4 eggs or egg shells upon individual apples, though this was by no means an average. Side injury was rather frequent on trees where eggs or egg shells were abundant, the point of entrance being usually half an inch or more from the egg. The affected tissues extended only to about one-twelfth of an inch in depth and were injured by the small larvae penetrating through the skin and then running a circular or nearly circular gallery in the outer layers of the fruit, the radius of this gallery being approximately one-sixteenth of an inch. The young larvae appear to remain in these holes rarely more than several days and then migrate to the blossom end of the fruit. This was evidenced by the fact that on the 8th, as observed by Mr Strickland, eggs were found in numbers on the apples and only a little side injury, while on the 13th there was considerable injury and most of the larvae had deserted the initial point of entrance and were frequently found in the blossom end. One larva was observed wandering on the surface of an apple, another on the tip of the calyx and a number were found in the calyx cavity, several of the latter being dead. Apples with the stamens partly eaten off or fully devoured were not uncommon. This feeding was speedily followed and sometimes preceded by the young larvae excavating a circular gallery in the succulent tissues at the base of the calyx

cup. These observations, in connection with those recorded above as to the occurrence of the poison upon the floral organs, shows where many of the pests were destroyed.

The week of July 5th, according to Mr Strickland's observations, was the earliest date this year when he found eggs on the leaves or apples, relatively few being seen upon the former. Furthermore, the fruit bore no evidence of previous side injury and it is probable that this does not occur until the apple is an inch or more in diameter and loses, in large measure, the pubescence of the very young fruit. Some half-grown larvae were observed in the apples, though one-third grown larvae were plainly more numerous. The presence of these indicate an earlier oviposition by moths from overwintering larvae.

The third application in this orchard was made to the 6 experimental trees of plot 3, July 26th, the day being bright, clear and hot. The apples were then in excellent condition and the trees bore a fair amount of fruit on all plots. The check trees showed a decidedly larger proportion of wormy apples.

Newfane orchard, plot 1 (sprayed once), 1915

TREE		NO.	PERFECT	SCAB	LEAF ROLLER OR GREEN FRUIT WORM	CODLING MOTH, WORMY Total	CODLING MOTH, WORMY End	CODLING MOTH, WORMY Side July	CODLING MOTH, WORMY Side August	END AND SIDE JULY	END AND SIDE AUGUST
A	Drops	23	0	19	4	23	6	14	11	0	0
	Picked	524	36	466	104	112	19	76	29	3	3
	Total	547	36	485	108	135	25	90	40	3	3
	Per cent	....	6.58	88.66	19.74	24.68	4.57	16.45	7.31	.54	.54
B	Drops	20	0	12	3	7	3	4	0	0	0
	Picked	1 799	193	1 578	120	174	19	150	64	39	0
	Total	1 819	193	1 590	123	181	22	154	64	39	0
	Per cent	....	10.61	87.41	6.76	9.94	1.21—	8.46	3.51	2.14	0
C	Drops	28	0	19	4	24	6	8	10	0	0
	Picked	1 335	152	1 042	161	215	11	156	93	4	2
	Total	1 363	152	1 061	165	239	17	164	103	4	2
	Per cent	....	11.15	77.84	12.10	17.53	1.24	12.03	7.55	.29	.14
D	Drops	5	4	0	1	0	0	0	0	0	0
	Picked	306	34	230	57	41	2	29	10	0	0
	Total	311	38	230	58	41	2	29	10	0	0
	Per cent	....	12.21	73.95	18.64	13.18	.64	9.32	3.21	0	0
E	Drops	46	11	15	7	13	7	6	0	0	0
	Picked	832	131	645	137	78	11	55	30	4	5
	Total	878	142	660	144	91	18	61	30	4	5
	Per cent	....	16.17	75.17	16.40	10.36	2.05	6.94	3.41	.45	.56
F	Drops	12	7	2	2	5	3	3	3	3	0
	Picked	461	94	288	109	37	4	11	22	1	2
	Total	473	101	290	111	42	7	14	25	4	2
	Per cent	....	21.35	61.31	23.46	8.87	1.47	2.95+	5.28	.84	.42
Grand total	....	5 391	662	4 316	709	729	91	512	272	54	12
	Per cent	....	12.20	80.05	13.15	13.52	1.68	9.49	5.04	1.00	.22

It will be seen from the tabulation on page 20 that the yield of individual trees in plot 1 ranged from 311 to 1819, an undesirable variation so far as making close comparisons are concerned. The number of wormy apples varies approximately with the yield excepting in the case of tree A which had 135 or over 24 per cent of the total yield wormy. A note made at the time of spraying shows that one corner of this tree was not covered so satisfactorily as some of the others. Excluding this tree, the percentage of wormy fruit varies from 8.87 to 17.53. It will be observed that in each instance a large percentage of the infestation is in the side of the fruit and due to late-hatching caterpillars of the first brood. The average percentage of wormy fruit for the plot is 13.52 per cent, while the side injury, due to eggs hatching in July, amounts to 9.49 per cent.

Newfane orchard, plot 2 (sprayed twice), 1915

TREE		NO.	PERFECT	SCAB	LEAF ROLLER OR GREEN FRUIT WORM	CODLING MOTH, WORMY			
						Total	End	Side July	Side August
A	Drops......	46	8	24	9	19	2	17	0
	Picked.....	1 173	278	695	157	133	9	115	26
	Total......	1 219	286	719	166	152	11	132	26
	Per cent....	......	23.46	58.98	13.61	12.46	......	10.82	....
B	Drops......	42	25	10	3	8	1	6	3
	Picked.....	548	244	247	28	67	1	47	28
	Total......	590	269	257	31	75	2	53	31
	Per cent....	......	45.59	43.55	5.25	12.71	......	8.98	....
C	Drops......	22	5	11	3	11	3	8	6
	Picked.....	1 168	565	315	198	163	8	121	67
	Total......	1 190	570	326	201	174	11	129	73
	Per cent....	......	47.9—	27.4—	16.9—	14.62	.....	10.84	....
D	Drops......	58	41	12	3	9	1	7	1
	Picked.....	1 337	672	439	164	135	6	108	51
	Total......	1 395	713	451	167	144	7	115	52
	Per cent....	......	51.11	32.32	11.97	10.32	......	8.24	....
E	Drops......	12	2	6	2	4	1	4	1
	Picked.....	590	234	241	60	108	1	87	54
	Total......	602	236	247	62	112	2	91	55
	Per cent....	......	39.20	41.02	10.3—	18.60	......	15.11	....
F	Drops......	14	0	4	3	4	2	4	2
	Picked.....	628	278	254	102	62	3	50	27
	Total......	642	278	258	105	66	5	54	29
	Per cent....	......	43.30	40.18	16.35	10.28	......	8.41	....
Grand total...		5 638	2 352	2 258	732	723	38	574	266
Per cent..........		......	41.71	40.04	12.98	12.82	.67	10.10	4.71

The trees on plot 2 bore a more uniform crop, the apples on individual trees ranging from 590 to 1395 and the infestation by the codling moth is likewise somewhat uniform, the percentage of

wormy fruit ranging for individual trees, from 10.28 to 14.62. Here, as in the preceding plot, by far the greater proportion of the apples were injured by late-hatching larvae, the percentage of such apples ranging for individual trees, from 8.24 to 15.11.

Newfane orchard, plot 3 (sprayed three times), 1915

TREE		NO.	PERFECT	SCAB	LEAF ROLLER OR GREEN FRUIT WORM	CODLING MOTH, WORMY			
						Total	End	Side July	Side August
A	Drops......	14	7	3	1	4	1	3	0
	Picked.....	720	373	226	72	120	3	99	33
	Total......	734	380	229	73	124	4	102	33
	Per cent....	......	51.77	31.19	9.94	16.89	......	13.89	....
B	Drops......	34	20	4	1	10	6	4	0
	Picked.....	1 511	709	423	151	320	11	178	84
	Total......	1 545	729	427	152	330	17	182	84
	Per cent....	......	47.18	27.63	9.83	21.35	......	11.77	....
C	Drops......	17	7	3	2	8	1	7	0
	Picked.....	301	158	45	41	76	1	63	17
	Total......	318	165	48	43	84	2	70	17
	Per cent....	......	51.88	15.09	13.52	26.41	......	22.01	....
D	Drops......	8	3	2	2	2	0	2	0
	Picked.....	525	323	90	66	75	1	53	33
	Total......	533	326	92	68	77	1	55	33
	Per cent....	......	61.16	17.26	12.75	14.44	......	10.31	....
E	Drops......	37	15	9	5	13	3	10	0
	Picked.....	1 034	634	118	170	157	4	139	25
	Total......	1 071	649	127	175	170	7	149	25
	Per cent....	......	60.50	11.85	16.34	15.87	......	13.81	....
F	Drops......	49	21	13	5	15	2	13	1
	Picked.....	1 858	1 097	504	163	215	3	179	68
	Total......	1 907	1 118	517	168	230	5	192	69
	Per cent....	......	58.62	27.11	8.81—	12.06	......	10.06	....
Grand total...		6 108	3 367	1 440	679	1 015	36	750	261
Per cent..........		......	55.10	23.57	11.11	16.61	.58	12.27	4.27

The trees in plot 3 present as great a variation in yield as in plot 1, the apples to each tree ranging from 318 to 1907. There is likewise a considerable variation in the percentage of wormy fruit, it ranging for individual trees from 12.06 to 26.41, by far the greater proportion, however, being due to injury from late-hatching eggs, this latter being responsible for from 10.06 to 22.01 per cent of the affected fruit.

Check trees, Newfane orchard, 1915

TREES	PICKED		DROPS		TOTALS		PER CENT	
	X	Y	X	Y	X	Y	X	Y
Perfect	7	4	2	0	9	4	1.25	1.50
Scab	563	205	65	33	628	238	87.71	90.49
Leaf roller or green fruit worm	45	33	10	11	55	44	7.69	16.72
End wormy	36	37	24	45	60	82	8.48	31.17
End and side wormy, July	40	19	25	20	65	39	9.07	14.64
End and side wormy, August	1	7	1	4	2	11	......	4.18
End and side wormy, July and August	14	8	10	2	24	10	3.35	3.80
Side wormy, July	194	66	21	33	215	99	30.02	37.64
Side wormy, August	25	23	0	4	25	27	3.49	10.26
Side wormy, July and August	224	1	7	0	231	1	32.26	....
Total wormy	424	114	89	54	513	168	71.64+	63.87
Total end wormy	.....	.....	.....	.....	151	142	21.08	53.99
Total side wormy	.....	.....	.....	.....	471	138	65.76	52.47
Total fruit	625	209	91	54	716	263	......	....

The two check trees, it will be seen by referring to the tabulation above, were very badly infested, 71.64 per cent being wormy in the case of tree X and 63.87 per cent in the case of tree Y. A very large proportion of this injury was due to the work of larvae hatching from late-deposited eggs, and in the case of tree X this amounted to 30.2 per cent and in that of tree Y to 37.64 per cent. These percentages relate only to side injury due to the activities of the first brood. Tree X, in addition, had 32.2 per cent entered at the side by both larvae of the first and second broods, a total side wormy for this tree of 65.76 per cent, while the total side infestation for tree Y amounts to 52.47 per cent.

Newfane orchard, summary of plots, 1915

PLOTS	NO.	PERFECT	SCAB	LEAF ROLLER OR GREEN FRUIT WORM	CODLING MOTH, WORMY			
					Total	End	Side July	Side August
1 Total	5 391	662	4 316	709	729	91	512	272
Per cent	......	12.20	80.05	13.15	13.52	1.68	9.49	5.04
2 Total	5 638	2 352	2 258	732	723	38	574	266
Per cent	......	41.71	40.04	12.98	12.82	.67	10.10	4.71
3 Total	6 108	3 367	1 440	679	1 015	36	750	261
Per cent	......	55.10	23.57	11.11	16.61	.58	12.27	4.27
Total, sprayed Plots	17 137	6 381	8 014	2 120	2 467	165	1 836	799
Per cent	......	37.23	46.76	12.37	14.39	.96	10.71	4.66
Checks, total	979	13	866	99	681	293	684	331
Per cent	......	1.32	88.45	10.11	69.56	29.92	69.86	33.81

A study of the summary of the plots in this orchard gives a better idea of the results actually obtained. The total yield to each plot did not vary greatly and it will be noted that there was a progressive increase in the perfect fruit, resulting from the additional sprayings and due largely to the better control of scab, the percentage of apples infected by this fungus being reduced from 80.5 per cent in plot 1 to 40.4 per cent in plot 2, and 23.57 per cent in plot 3.

The three sprayings for the codling moth, it will be seen by reference to the tabulation, had very little influence in reducing leaf roller injury.

The percentages of wormy apples obtained from the three plots show no material benefit in worm-free fruit from the second and third applications. In fact, there is a larger percentage of wormy apples on plot 3 than plot 1, which is probably due to some factor which can not be readily explained at the present time. It will be noted that there is a progressive increase in the side injury, resulting from the work of late-hatching larvae of the first brood. This, likewise, we believe to be largely accidental.

The percentage of wormy fruit on the two check trees is so high that it is not surprising that better results should not have been obtained by spraying. The treatment on each of the three plots has reduced the percentage of wormy apples by over 55 per cent. This of itself is striking testimony to the value of poisoned applications for the destruction of the codling moth, though we would not give the impression that the results obtained in this orchard, striking though they be, are entirely satisfactory.

Kendall orchard

This greening orchard, the property of Mr H. E. Wellman, is bounded on the west by a highway, a rather well-marked drive on the south and extends north to another highway. Eleven trees lie between the experimental plots and the western highway.

Plot 1 was located 3 trees north from the southern margin, plot 2, 9 trees north, and plot 3, 15 trees north, the check trees being 22 trees north. The bloom in this orchard, while heavy on the rows containing the actual experimental trees, was somewhat irregular, and it was therefore not feasible to have the plots separated by more than 3 trees. Two rows on each side were used as barriers. The orchard is about 40 years old, the trees being set 33 by 33 feet and large enough so that the branches are moderately close but not so near as to prevent satisfactory spraying. Mr Wellman states that it has been his practice to do a very thorough job when making the calyx application, treating the nonfruiting as well as the bearing

trees. The amount of spraying later, however, depended upon the crop prospects.

The first application was made May 22d, 18 pounds of Niagara arsenate of lead (15 per cent arsenic oxide), $6\frac{1}{2}$ gallons of Dow's lime-sulphur wash (33° Baumé) being used to 250 gallons of spray. The pressure was maintained at about 200 pounds. One man stood on an 11 foot tower and the other on the ground, the latter provided with 50 feet of hose and both equipped with 10 foot extensions. The average time to each tree was $2\frac{1}{10}$ minutes, the amount of spray being $5\frac{1}{5}$ gallons. The blossoms were two-thirds or more off and the remainder were falling fast. The weather was sunny with light clouds and a variable breeze in the orchard, which latter proved to be a stiff breeze on the highway.

The man on the tower covered the top of one tree and touched up the inner side of the windward row, while the man on the ground went around the tree and also touched up the inner side of the windward row. The distribution of the spray was very uniform, there being practically no unsprayed areas and almost no overloading of the foliage. In fact, a large percentage of the leaves were lightly specked with the poison while very few showed a running and gathering at the tip. Brown angle nozzles were used with a rather fine disk and the spray was driven only to a slight extent, say 3 or 4 feet in the light breeze prevailing.

One codling moth larva was observed transforming to the pupa and another had partly changed. Bud moth, case-bearers and green fruit worms were present in small numbers, while leaf roller larvae were somewhat abundant.

A second spraying of plots 2 and 3 was given June 8th. The day was clear with a variable and rather strong, whirling breeze. Approximately 10 gallons were used to each tree. The barrier rows on plots 2 and 3 were sprayed later though not under supervision.

There was great disparity in the development of the leaf rollers, some being in the pupa stage, others nearly full grown and a number partly grown. There was considerable leaf roller work upon the foliage and many young apples were partly eaten by this pest.

The first spraying of the season, originally intended for San José scale, was not given until after the buds had started perceptibly, the leaves being probably from one-fourth to three-fourths of an inch long. On this account Mr Wellman used 3 pounds of arsenate of lead to 50 gallons of water and the lime-sulphur wash at the rate of 1 to 15, together with three-fourths of a pint of black leaf 40 to 100 gallons in an attempt to control the scale, leaf roller and plant lice with one application. The probabilities are that the leaves had

started to such an extent that the leaf rollers were able to penetrate the buds and thus, in large measure, avoid the poison. There appeared to be at this time more leaf roller injury to both fruit and foliage of the check trees.

An examination of this orchard July 14th showed a few recently laid eggs and some side injury on the greenings and decidedly more on the adjacent Baldwins. Some larvae were found in the calyx cup. The setting of fruit on the experimental trees is scanty and the crop has been still more reduced by a heavy drop.

Plot 3 was sprayed for the third time July 28th, the day being cloudy and still and the conditions almost perfect for good work. The trees were well covered with the spray and dripped a little. The work began at 8.45 a.m., was completed about 10 a.m. and rain began falling about 10.30 and continued most of the afternoon. The same formula was employed as before and possibly a little more spray was applied, since the pressure tended to remain at about 210 pounds. Side injury was easily found and some eggs were observed in the red stage though no recently deposited ones were seen.

Kendall orchard, plot 1 (sprayed once), 1915

TREE		NO.	PERFECT	SCAB	LEAF ROLLER OR GREEN FRUIT WORM	CODLING MOTH, WORMY			
						Total	End	Side July	Side August
A	Drops	20	4	3	11	11	1	10	0
	Picked	760	330	502	233	170	0	159	11
	Total	780	334	505	244	181	1	169	11
	Per cent	......	42.82	64.74	31.28	23.20	......	21.66	....
B	Drops	41	1	9	20	35	2	32	1
	Picked	496	148	247	168	162	1	154	7
	Total	537	149	256	188	197	3	186	8
	Per cent	......	27.74	47.67	35.00	36.68	......	34.63	....
C	Drops	34	4	1	13	16	2	19	0
	Picked	571	223	168	181	151	1	136	14
	Total	605	227	169	194	167	3	155	14
	Per cent	......	37.52	27.93	32.06	27.60	......	25.62	....
D	Drops	52	10	13	13	33	0	33	0
	Picked	1 699	690	547	520	506	1	450	55
	Total	1 751	700	560	533	539	1	483	55
	Per cent	......	39.97	31.98	30.43	30.78	......	27.58	....
E	Drops	35	5	3	16	23	11	21	0
	Picked	1 430	530	422	339	236	1	225	10
	Total	1 465	535	425	355	259	12	246	10
	Per cent	......	36.51	29.01	24.23	17.67	......	16.79	....
F	Drops	36	2	8	17	30	5	35	0
	Picked	424	160	119	149	176	3	145	28
	Total	460	162	127	166	206	8	180	28
	Per cent	......	35.21	27.60	36.08	44.78	......	39.13	....
	Grand total	5 598	2 107	2 042	1 680	1 549	28	1 419	126
Per cent			37.63	36.45	30.01	27.67	.50	25.34	2.25

It will be seen from the tabulation on page 26 that the yield of trees in plot 1 ranged from 460 to 1751, a rather wide variation which is not accompanied by a corresponding difference in the number of wormy apples. The percentage of the latter on individual trees varies from 17.67 to 44.78, the lowest percentage being upon one of the most fruitful trees, while the highest was, as might be expected, on the tree producing the smallest crop. The average percentage of wormy apples for this plot was 27.67, the injuries by late-hatching larvae amounting to 25.34. Even in the case of the tree with the lowest percentage of wormy apples, by far the most injury resulted from the late egg deposition, this being 16.79 per cent out of a total of only 17.67. The damage resulting from end wormy infestations was almost negligible, it amounting to half of 1 per cent.

Kendall orchard, plot 2 (sprayed twice), 1915

TREE		NO.	PERFECT	SCAB	LEAF ROLLER OR GREEN FRUIT WORM	CODLING MOTH, WORMY			
						Total	End	Side July	Side August
A	Drops	12	0	0	6	13	1	12	0
	Picked	319	125	59	117	103	1	96	7
	Total	331	125	59	123	116	2	108	7
	Per cent	......	37.76	17.82	37.16	35.04	......	32.62	....
B	Drops	14	0	1	11	12	3	9	0
	Picked	378	115	27	204	140	0	127	13
	Total	392	115	28	215	152	3	136	13
	Per cent	......	29.33	7.11	54.84	38.77	......	34.69	....
C	Drops	12	1	1	9	10	0	10	0
	Picked	371	135	44	186	101	2	98	1
	Total	383	136	45	195	111	2	108	1
	Per cent	......	35.50	11.74	50.91	28.98	......	28.19	....
D	Drops	11	1	1	8	10	2	8	0
	Picked	243	114	23	78	59	0	56	3
	Total	254	115	24	86	69	2	64	3
	Per cent	......	45.11	9.44	33.85	27.16	......	25.19	....
E	Drops	15	5	1	5	8	0	8	0
	Picked	1 001	437	148	354	269	4	255	15
	Total	1 016	442	149	359	277	4	263	15
	Per cent	......	43.50	14.66	35.34	27.26	......	25.88	....
F	Drops	13	2	2	6	11	1	10	0
	Picked	458	157	36	210	165	1	148	16
	Total	471	159	38	216	176	2	158	16
	Per cent	......	33.75	8.07	45.85	37.36	......	33.54	....
Grand total		2 847	1 092	343	1 194	901	15	837	55
Per cent		......	38.35	12.04	41.93	31.64	.52	29.39	1.93

The yield on plot 2 was low and more uniform than in the case o plot 1, the number of apples to each tree ranging from 331 to 1016, while the percentage of wormy apples to each tree was fairly uniform

and varied from 27.16 to 38.77. Here, as in plot 1, a very large proportion of the apples were damaged by late-hatching larvae, the injury for individual trees in no case falling below 25.19 per cent and ranging from this to 34.69 per cent. The average infestation for the plot was 31.64 per cent, of which .52 per cent was due to end wormy infestation, 29.39 per cent to the characteristic side injury damage and 1.93 per cent to late infestation by the second brood.

Kendall orchard, plot 3 (sprayed three times), 1915

TREE		NO.	PERFECT	SCAB	LEAF ROLLER OR GREEN FRUIT WORM	CODLING MOTH, WORMY			
						Total	End	Side July	Side August
A	Drops......	7	2	0	3	5	1	4	0
	Picked.....	85	25	6	53	15	0	14	1
	Total......	92	27	6	56	20	1	18	1
	Per cent....	......	29.34	6.52	60.86	21.73	......	19.56	....
B	Drops......	5	1	0	3	13	0	3	0
	Picked.....	91	36	1	52	14	0	14	0
	Total......	96	37	1	55	27	0	17	0
	Per cent....	......	38.54	1.03	57.29	28.12	......	17.70	....
C	Drops......	14	1	0	10	10	0	10	0
	Picked.....	150	36	15	79	54	0	53	1
	Total......	164	37	15	89	64	0	63	1
	Per cent....	......	22.56	9.14	54.26	39.02	......	38.41	....
D	Drops......	44	3	2	21	32	2	30	0
	Picked.....	913	360	152	287	297	2	297	1
	Total......	957	363	154	308	329	4	327	1
	Per cent....	......	37.93	16.09	32.18	34.37	......	34.16	....
E	Drops......	5	1	0	3	3	0	3	0
	Picked.....	314	105	14	154	121	0	118	3
	Total......	319	106	14	157	124	0	121	3
	Per cent....	......	33.22	4.38	49.21	38.87	......	37.93	....
F	Drops......	2	0	0	2	2	0	2	0
	Picked.....	53	19	5	30	16	0	16	0
	Total......	55	19	5	32	18	0	18	0
	Per cent....	......	34.72	9.09	51.00	21.27	......	21.27	....
Grand total....		1 683	589	195	697	582	5	564	6
Per cent..........		......	34.99	11.52	41.41	34.52	.29	33.51	.35

The yield from plot 3 was decidedly lower than in the case of the two preceding, the product of individual trees ranging from 55 to 957 apples, while the percentage of wormy fruit varied from 21.27 to 39.02. This plot is characterized by an almost complete absence of end-wormy apples, the infestation amounting to only .29 per cent, while by far the most damage was caused by late-hatching larvae and amounted for the plot to 33.51 out of a total plot infestation of 34.52 per cent.

The yield on plot 3 was so light that two special trees just to the north and designated as trees AA and BB were also picked and the fruit classified to see if the conditions on these trees varied materially from those found to exist on the trees originally selected. The yield of these two trees, as will be seen by referring to the tabulation, was 634 and 410 apples, respectively, the percentage of wormy fruit being 32.33 and 39.26 per cent, with side injury amounting to 32.01 and 38.53 per cent, respectively. In other words, here as elsewhere in this orchard, a very large proportion of the wormy apples suffered from the late-hatching larvae.

Another tree designated CC was east of plot 2 and was supposed to have had three sprayings. It was selected because of the relatively large crop of apples, producing 3175. Here there was 20.44 per cent wormy, 18.96 per cent being classed as such because of the side injury. The relatively high percentage of scab infection, namely 47.14, indicates that this tree may not have been sprayed so thoroughly as some others. All three of these special trees, like those in plot 3, are remarkable because of the almost total absence of end-wormy apples.

Kendall orchard, special trees (sprayed), 1915

TREE		NO.	PERFECT	SCAB	LEAF ROLLER OR GREEN FRUIT WORM	CODLING MOTH, WORMY			
						Total	End	Side July	Side August
AA	Drops	17	2	3	7	9	1	8	0
	Picked	617	229	74	242	196	0	195	1
	Total	634	231	77	249	205	1	203	1
	Per cent	......	36.43	12.14	39.27	32.33	......	32.01	....
BB	Drops	30	3	2	17	16	1	15	0
	Picked	380	110	61	183	145	0	143	2
	Total	410	113	63	200	161	1	158	2
	Per cent	......	27.55	15.36	48.78	39.26	......	38.53	....
CC	Drops	128	16	55	46	65	0	61	4
	Picked	3 047	1 161	1 442	713	584	0	541	43
	Total	3 175	1 177	1 497	759	649	0	602	47
	Per cent	......	37.07	47.14	23.90	20.44	......	18.96	....
Grand total		4 219	1 521	1 637	1 208	1 015	2	963	50
Per cent		......	36.05	38.80	28.63	24.05	.04	22.82	1.18

Kendall orchard, checks (unsprayed), 1915

TREE		NO.	PERFECT	SCAB	LEAF ROLLER OR GREEN FRUIT WORM	CODLING MOTH, WORMY			
						Total	End	Side July	Side August
X	Drops	34	2	12	12	34	5	28	1
	Picked	169	17	115	56	89	0	81	8
	Total	203	19	127	68	123	5	109	9
	Per cent	......	9.35	62.56	33.49	60.59	......	53.69	....
Y	Drops	99	3	44	21	95	12	83	0
	Picked	349	41	248	89	212	1	181	24
	Total	448	44	292	110	307	13	264	24
	Per cent	......	9.82	65.17	24.55	68.52	......	58.92	....
Grand total		651	63	419	178	430	18	373	33
Per cent		......	9.52	62.82	27.34	67.58	2.76	57.29	5.06

The check trees bore 203 and 448 apples, the percentage of wormy fruit being 60.59 and 68.52, respectively. The end-wormy apples are relatively very few and by far the greater portion of the injury in this orchard, as on the unsprayed trees, was due to late-hatching larvae, practically all but 10 per cent of the affected fruit for the two trees being affected in this way.

Kendall orchard, summary of plots, 1915

PLOTS	NO.	PERFECT	SCAB	LEAF ROLLER OR GREEN FRUIT WORM	CODLING MOTH, WORMY			
					Total	End	Side July	Side August
1 Total	5 598	2 107	2 042	1 680	1 549	28	1 419	126
Per cent	......	37.63	36.45	30.01	27.67	.50	25.34	2.25
2 Total	2 847	1 092	343	1 194	901	15	837	55
Per cent	......	38.35	12.04	41.93	31.64	.52	29.39	1.93
3 Total	1 683	589	195	697	582	5	564	6
Per cent	......	34.99	11.52	41.41	34.52	.29	33.51	.35
Special, total	4 219	1 521	1 637	1 208	1 015	2	963	50
Per cent	......	36.05	38.80	28.63	24.05	.04	22.82	1.18
Total, sprayed plots	14 347	5 309	4 217	4 779	4 047	50	3 783	237
Per cent	......	37.	29.39	33.31	28.20	.34	26.29	1.65
Checks, total	651	63	419	178	430	18	373	33
Per cent	......	9.52	62.82	27.34	67.58	2.76	57.29	5.06

A study of the summary of the plots gives in brief compass an idea of the results obtained. It will be noted first of all that the yields of plots 1, 2 and 3 decreased, each being about one-half smaller than

the preceding, and that the percentage of perfect fruit remained about the same in plots 1 and 2, despite the decrease in yield, while in plot 3 it was smaller, the variation in each instance being due to the small yield of the plots receiving more than one application. A decrease in the percentage of scab infection is to be noted on these three plots, though there is little variation between plots 2 and 3, while there is a higher and nearly identical percentage of leaf roller injury on plots 2 and 3. There is a nearly regular increase in the percentage of wormy apples in these three plots, due almost entirely to the progressive reduction in the crop. This is practically paralleled by the increased percentage of blemishes caused by late-hatching larvae.

Compared with the checks or unsprayed trees, these three plots show a marked improvement, making due allowance for the reduced yield of plots receiving more than one spray in the percentage of perfect apples and the reduction in percentage of scabby fruit. There is also a very marked reduction in wormy apples. It will be noted that a summary of the data from the special trees given above, is not materially different from that obtained on the regular experimental trees.

Webster orchard

This was an exceptionally fine Baldwin orchard managed by Mr J. A. Talbot of Spencerport, to whom we are indebted for most hearty cooperation. The orchard is well cultivated, the trees being 38 to 40 years old and standing about 40 feet apart with plenty of room for efficient spraying. It is located just north of a highway and three plots with two check trees were laid out as follows:

Plot 1 was 2 trees north of the highway and 2 trees east of the western boundary.

Plot 2 was 9 trees north of the highway and 2 trees east of the western boundary.

Plot 3 was 2 trees north of the highway and 8 trees east of the western boundary.

The check trees were 13 trees north of the highway and 2 trees east of the western boundary.

Plots 1, 2 and 3 were therefore well separated by the usual barrier trees, 2 on each side though but 1 tree separated the northern trees of plot 2, namely, A and B, from the check trees X and Y.

The spraying was done May 20th, Rex lime and sulphur being used at the rate of 1 to 40 and Ansbacher arsenate of lead at the rate of 3 pounds to 50 gallons of water; 15 pounds of freshly slaked,

good stone lime were also added to each 200 gallons of the spray. The pressure was maintained at about 175 pounds. Two lines of hose were used, one man being upon the outfit and the second working from the ground. At the time of spraying more than two-thirds of the blossoms were off and the others were dropping rapidly. There was a light breeze, the day was bright and bees were not working in the orchard. One tank full, or 200 gallons, sufficed for 22 trees, the time of application being approximately 35 minutes. It required from 20 to 25 minutes to fill the tank. The distribution was very satisfactory, few or no leaves being skipped and there was very little dripping. Freedom from insect pests, especially leaf roller and aphis, was evident though a few case-bearers were observed.

The second spraying was made on plots 2 and 3 June 9th. The same formula was employed as before, the day was bright and 200 gallons sufficed to spray 33 trees. The work began at 8.43 a.m. and was completed by 11.30. Leaf roller work was evident, some pupae being observed, and a number of case-bearers occurred here and there, their work being somewhat evident both upon foliage and fruit.

Observations July 14th showed some leaf roller injury and more damage by the case-bearer than appeared in other orchards. There was also a perceptible amount of hail injury. The side injury caused by young codling moth larvae was prevalent to some extent, though the infestation was decidedly less than in any other of the experimental orchards. The conditions approximated those we would expect to find in similar orchards in the Hudson valley.

The third spraying was given plot 3 July 29th, 200 gallons being used for 40 trees; 3 pounds of arsenate of lead, lime-sulphur 1 to 50 was the formula employed. No eggs and comparatively little side injury were seen.

Webster orchard, plot 1 (sprayed once), 1915

TREE		NO.	PERFECT	SCAB	LEAF ROLLER OR GREEN FRUIT WORM	CODLING MOTH, WORMY			
						Total	End	Side July	Side August
A	Drops......	307	145	115	37	36	2	34	0
	Picked.....	2 789	1 495	1 077	215	133	1	133	4
	Total......	3 096	1 640	1 192	252	169	3	167	4
	Per cent....	......	52.97	38.50	8.13	5.45	......	5.39	....
B	Drops......	329	181	93	45	35	3	33	0
	Picked.....	3 610	1 724	1 627	281	104	2	97	5
	Total......	3 939	1 905	1 720	326	139	5	130	5
	Per cent....	......	48.35	43.51	8.27	3.52	......	3.30	....
C	Drops......	98	53	20	6	23	6	19	0
	Picked.....	2 074	1 051	948	111	104	2	104	0
	Total......	2 172	1 104	968	117	127	8	123	0
	Per cent....	......	50.71	44.56	5.37	5.71	......	5.66	....
D	Drops......	358	143	146	33	49	6	44	0
	Picked.....	4 634	1 979	2 538	210	234	1	230	4
	Total......	4 992	2 122	2 684	243	283	7	274	4
	Per cent....	......	42.50	53.76	4.86	5.66	......	5.48	....
E	Drops......	342	150	133	27	45	3	42	1
	Picked.....	4 431	2 137	2 095	210	200	0	196	1
	Total......	4 773	2 287	2 228	237	245	3	238	2
	Per cent....	......	47.91	46.67	4.96	5.13	......	4.98	....
F	Drops......	125	50	59	9	20	1	19	0
	Picked.....	4 406	2 183	1 984	153	241	1	237	14
	Total......	4 531	2 233	2 043	162	261	2	256	14
	Per cent....	......	49.28	45.08	3.57	5.75	......	5.65	....
Grand total...		23 503	11 291	10 835	1 337	1 224	28	1 188	29
Per cent..........		......	48.04	46.10	5.68	5.20	.11	5.05	.12

The crop on this plot was large, ranging for individual trees from 2172 to 4992, the percentage of wormy apples varying from 3.52 to 5.75. This range is by no means large, though it would have been much smaller but for the side injury caused by late-hatching larvae, this ranging from 3.30 to 5.66 per cent. A very small proportion, only .11 per cent, was end wormy. These gratifying results are in part due to the large crop though they are mostly to be accounted for, in our judgment, by the thorough and systematic spraying which appears to have been the rule for several years past.

Webster orchard, plot 2 (sprayed twice), 1915

TREE		NO.	PERFECT	SCAB	LEAF ROLLER OR GREEN FRUIT WORM	CODLING MOTH, WORMY			
						Total	End	Side July	Side August
A	Drops......	124	125	50	25	15	2	13	0
	Picked.....	2 498	1 763	592	124	46	0	46	0
	Total......	2 622	1 888	642	149	61	2	59	0
	Per cent....	......	72.	24.48	5.68	2.32	....	2.25	....
B	Drops......	281	133	90	39	35	3	33	0
	Picked.....	2 168	1 489	499	164	49	0	48	0
	Total......	2 449	1 622	589	203	84	3	81	0
	Per cent....	......	66.23	24.05	8.28	3.42	....	3.30	....
C	Drops......	171	100	43	19	18	1	18	0
	Picked.....	2 125	1 514	493	102	49	0	49	1
	Total......	2 296	1 614	536	121	67	1	67	1
	Per cent....	......	70.29	23.34	5.27	2.91	....	2.91	....
D	Drops......	109	62	28	9	8	0	8	0
	Picked.....	1 888	1 263	475	118	69	0	69	1
	Total......	1 997	1 325	503	127	77	0	77	1
	Per cent....	......	66.34	25.18	6.35	3.85	....	3.85	....
E	Drops......	399	223	95	51	49	3	45	1
	Picked.....	2 341	1 681	484	162	47	0	44	3
	Total......	2 740	1 904	579	213	96	3	89	4
	Per cent....	......	69.48	21.13	7.77	3.50	....	3.24	....
F	Drops......	454	242	136	39	52	3	50	0
	Picked.....	3 046	1 934	1 097	235	74	1	73	2
	Total......	3 500	2 176	1 233	274	126	4	123	2
	Per cent....	......	62.17	35.22	7.87	3.6	....	3.51	....
Grand total...		15 604	10 529	4 082	1 087	511	13	496	8
Per cent..........		......	67.47	26.15	6.97	3.27	.08	3.17	.05

The yield of plot 2 is considerably less than that of plot 1, the crop from individual trees ranging from 1997 to 3500 apples. The percentage of wormy fruit is perceptibly lower than in the preceding, it varying from 2.32 to 3.85, by far the greater proportion, as in the preceding plot, being due to side injury. The end wormy in this plot amounted to only .08 per cent.

Webster orchard, plot 3 (sprayed three times), 1915

TREE		NO.	PERFECT	SCAB	LEAF ROLLER OR GREEN FRUIT WORM	CODLING MOTH, WORMY			
						Total	End	Side July	Side August
A	Drops	484	261	145	65	30	1	29	1
	Picked	3 056	2 475	377	168	82	1	80	2
	Total	3 540	2 736	522	233	112	2	109	3
	Per cent	......	77.28	14.74	6.58	3.16	......	3.07	....
B	Drops	226	145	44	26	17	1	17	0
	Picked	2 684	2 146	361	128	69	......	69	0
	Total	2 910	2 291	405	154	86	1	86	0
	Per cent	......	78.72	13.91	5.29	2.95	......	2.95	....
C	Drops	403	232	104	42	34	2	32	0
	Picked	3 459	2 607	673	110	97	......	97	0
	Total	3 862	2 839	777	152	131	2	129	0
	Per cent	......	73.51	20.11	3.95	3.39	......	3.34	....
D	Drops	400	241	99	37	38	4	35	0
	Picked	2 900	2 097	637	139	69	0	69	0
	Total	3 300	2 338	736	176	107	4	104	0
	Per cent	......	70.84	22.30	5.33	3.24	......	3.15	....
E	Drops	342	109	81	42	57	0	57	0
	Picked	4 622	3 455	927	148	160	0	160	2
	Total	4 964	3 564	1 008	190	217	0	217	2
	Per cent	......	71.79	20.30	3.82	4.37	......	4.37	....
F	Drops	310	221	20	29	49	1	48	0
	Picked	3 153	2 712	203	104	161	0	160	1
	Total	3 463	2 933	223	133	210	1	208	1
	Per cent	......	84.40	6.43	3.84	6.06	......	6.	....
Grand total		22 039	16 701	3 671	1 038	863	10	853	6
Per cent		......	75.77	16.65	4.70	3.91	.04	3.87	.02

The yield of this plot approximates that of the first, individual trees varying from 2910 to 4964 apples and the percentage of wormy ranging from 2.95 to 6.06. There is a wider variation in the wormy fruit than obtains on trees in the other plots, though the average for the plot is decidedly less than in plot 1 and only a little more than in plot 2. This discrepancy is probably explainable by variations in application which it is almost impossible to avoid under practical conditions. Here as in the preceding plots, the greater proportion of the wormy fruit has been injured by the late-hatching larvae of the first brood, only .04 per cent being end wormy.

Webster orchard, checks (unsprayed), 1915

TREE		NO.	PERFECT	SCAB	LEAF ROLLER OR GREEN FRUIT WORM	CODLING MOTH, WORMY			
						Total	End	Side July	Side August
X	Drops......	246	119	91	24	45	4	40	1
	Picked.....	1 892	499	1 295	133	81	1	78	3
	Total......	2 138	618	1 386	157	126	5	118	4
	Per cent....	......	28.90	64.82	7.34	5.89	......	5.51	....
Y	Drops......	352	78	187	50	92	11	77	1
	Picked.....	2 929	440	2 479	196	127	1	122	7
	Total......	3 281	518	2 666	246	219	12	199	8
	Per cent....	......	15.78	81.25	7.49	6.67	......	6.06	....
Grand total....		5 419	1 136	4 052	403	345	17	317	12
Per cent..........		......	20.96	74.77	7.43	6.36	.31	5.84	.22

The two check trees bore 2138 and 3281 apples, the percentage of wormy fruit being 5.89 and 6.67 respectively. Most of the affected apples bore the side injury of late-hatching worms of the first brood, though there is a perceptibly larger percentage of end-wormy fruit. The extremely low percentage, for check trees, of wormy apples is surprising and can be accounted for only by the very thorough and systematic spraying of earlier years. This view is further supported by the fact that examinations under nearby trees just across the road from the experimental orchard showed that 75 per cent of the apples lying on the ground were badly injured by the codling moth. This plainly indicates that the insect, if left to itself, would have been extremely abundant, and at least suggests that there may be great value in annual treatments whether the trees be in fruit or not.

Webster orchard, summary of plots, 1915

PLOTS	NO.	PERFECT	SCAB	LEAF ROLLER OR GREEN FRUIT WORM	CODLING MOTH, WORMY			
					Total	End	Side July	Side August
1 Total...........	23 503	11 291	10 835	1 337	1 224	28	1 188	29
Per cent........	......	48.04	46.10	5.68	5.20	.11	5.05	.12
2 Total...........	15 604	10 529	4 082	1 087	511	13	496	8
Per cent........	......	67.47	26.15	6.97	3.27	.08	3.17	.05
3 Total...........	22 039	16 701	3 671	1 038	863	10	853	6
Per cent........	......	75.77	16.65	4.70	3.91	.04	3.87	.02
Total sprayed Plots...........	61 146	38 521	18 588	3 462	2 598	51	2 537	43
Per cent........	......	62.99	30.39	5.66	4.24	.08	4.14	.07
Checks, total......	5 419	1 136	4 052	403	345	17	317	12
Per cent..........	......	20.96	74.77	7.43	6.36	.31	5.84	.22

The yield in this orchard was so uniform that the figures need comparatively little explanation, the one exception being that plot 2 produced a distinctly lighter crop than either plots 1 or 3. Despite this, there is a progressive increase with the number of sprayings from 48.04 to 75.77 per cent of perfect fruit and a correlated decrease from 46.10 to 16.65 per cent of scabby apples. It will be noted that a great reduction in scab infection resulted from the second spraying. These figures are in marked contrast to the 20.96 per cent perfect and the 74.77 per cent scabby fruit on the check trees. There is comparatively little, as in other plots, variation in the percentage of apples injured by the leaf roller. This amounts, for the three plots, to 5.68, 6.97 and 4.70, respectively. These discrepancies are more easily explained as normal differences among groups of trees to be found in every orchard rather than as results from the applications or minor deficiencies in treatment. The second spraying reduced the percentage of wormy fruit in this orchard approximately by 2 per cent, while the plot sprayed three times did not give quite so good results. This latter is presumably due to normal and unavoidable variations either in the trees or the treatment. It will be observed that most of the wormy apples were injured by the late-hatching larvae of the first brood and that only .08 per cent of the fruit on all the plots was entered at the end. The relatively small difference between the sprayed and the unsprayed trees, so far as wormy apples are concerned, has already been commented upon.

Summary of the one spray treatment, 1915

ORCHARD	NO.	PERFECT	SCAB	LEAF ROLLER OR GREEN FRUIT WORM	CODLING MOTH, WORMY			
					Total	End	Side July	Side August
Newfane								
Total	5 391	662	4 316	709	729	91	512	272
Per cent	......	12.20	80.05	13.15	13.52	1.68	9.49	5.04
Kendall								
Total	5 598	2 107	2 042	1 680	1 549	28	1 419	126
Per cent	......	37.63	36.45	30.01	27.67	.50	25.34	2.25
Webster								
Total	23 503	11 291	10 835	1 337	1 224	28	1 188	29
Per cent	......	48.04	46.10	5.68	5.20	.11	5.05	.12
Grand total	34 492	14 060	17 193	3 726	3 502	147	3 119	427
Per cent	......	40.76	49.84	10.80	10.15	.42	9.04	1.23

For the purpose of comparing results in different orchards following the same treatment, the data relating to the three plots receiving

only one spraying are compared above. It will be noted that there is a wide discrepancy in either the number or percentage of perfect apples, due largely to local conditions and resulting particularly from scab infection. There is also a considerable, though not such a wide variation in the amount of fruit injured by the leaf roller. The number and percentage of apples infested by the codling moth vary greatly in the different orchards and range from 5.20 to 27.67 per cent. This percentage difference is to be accounted for partly by the much larger crop in the Webster orchard, though it will be noted on comparing the results obtained in the Newfane and Kendall orchards, that the yield for each plot was approximately the same, while the percentage of infested apples was twice as great in the latter. Injury by larvae entering at the blossom end was comparatively small, while by far the greater part of the damage is to be attributed to late-hatching larvae entering the apples in July.

Summary of the two spray treatment, 1915

ORCHARD	NO.	PERFECT	SCAB	LEAF ROLLER OR GREEN FRUIT WORM	CODLING MOTH, WORMY			
					Total	End	Side July	Side August
Newfane								
Total	5 638	2 352	2 258	732	723	38	574	266
Per cent	......	41.71	40.04	12.98	12.82	.67	10.10	4.71
Kendall								
Total	2 847	1 092	343	1 194	901	15	837	55
Per cent	......	38.35	12.04	41.93	31.64	.52	29.39	1.93
Webster								
Total	15 604	10 529	4 082	1 087	511	13	496	8
Per cent	......	67.47	26.15	6.97	3.27	.08	3.17	.05
Grand total	24 089	13 973	6 683	3 013	2 135	66	1 907	329
Per cent	......	58.	27.74	12.50	8.86	.27	7.91	1.36

The three plots compared in the table present considerable differences as in the case of those receiving but one application, the percentage of perfect fruit being decidedly greater in the Webster orchard. This latter is easily accounted for to some extent at least, by the large crop and, within certain limits, relative freedom from scab infection. There are wide variations in the percentages of apples injured by the leaf roller, these varying from 6.97 per cent in the case of the Webster orchard to 41.93 per cent for the Kendall orchard. There is nearly as wide a range in the percentage of apples infested by the codling moth, by far the greater part of the damage being due to larvae hatching from late-deposited eggs.

Summary of the three spray treatment, 1915

ORCHARD	NO.	PERFECT	SCAB	LEAF ROLLER OR GREEN FRUIT WORM	CODLING MOTH, WORMY			
					Total	End	Side July	Side August
Newfane								
Total	6 108	3 367	1 440	679	1 015	36	750	261
Per cent	......	55.10	23.57	11.11	16.61	.58	12.27	4.27
Kendall								
Total	1 683	589	195	697	582	5	564	6
Per cent	......	34.99	11.52	41.41	34.52	.29	33.51	.35
Webster								
Total	22 039	16 701	3 671	1 038	863	10	853	6
Per cent	......	75.77	16.65	4.70	3.91	.04	3.87	.02
Grand total	29 830	20 657	5 306	2 414	2 460	51	2 167	273
Per cent	......	69.24	17.78	8.09	8.24	.17	7.26	.91

The plots receiving three applications differed most widely in the size of the crop, ranging from 1683 apples in the case of the Kendall orchard to 22,039 in the Webster orchard. The perfect fruit ranged from 34.99 to 75.77 per cent, a considerable proportion of this difference being due to variations in scab infection, although the leaf roller and codling moth were also responsible for many imperfect apples. The percentage injured by the former ranged from 4.70 to 41.41, and of the latter from 3.91 to 34.52, the greater relative injury invariably being on the plot bearing the smallest crop. End-wormy apples for the three plots amount to only .17 per cent, by far the greatest damage being done by larvae hatching in July.

Summary of check (unsprayed) tree records, 1915

ORCHARD	NO.	PERFECT	SCAB	LEAF ROLLER OR GREEN FRUIT WORM	CODLING MOTH, WORMY			
					Total	End	Side July	Side August
Newfane								
Total	979	13	866	99	681	293	684	331
Per cent	......	1.32	88.45	10.11	69.56	29.92	69.86	33.81
Kendall								
Total	651	63	419	178	430	18	373	33
Per cent	......	9.52	62.82	27.34	67.58	2.76	57.29	5.06
Webster								
Total	5 419	1 136	4 052	403	345	17	317	12
Per cent	......	20.96	74.77	7.43	6.36	.31	5.84	.22
Grand total	7 049	1 212	5 337	680	1 456	328	1 374	376
Per cent	......	17.19	75.71	9.64	20.65	4.65	19.49	5.33

The two check trees in each of the three unsprayed plots show wide variation in yield, ranging from 651 to 5419 apples for the Kendall and Webster orchards, respectively. The perfect fruit varied from 1.32 to 20.96 per cent, scab infecting 88.45 per cent of the apples in the Newfane orchard and 74.77 per cent in the Webster orchard. A considerable variation is also noticed in the amount of fruit injured by the leaf roller and the codling moth, this latter being particularly marked when the results obtained in the Webster orchard are compared with the other two plots. The most striking contrast is seen in the percentage of end wormy, this amounting in the case of the Newfane orchard to 29.92, while in the Kendall orchard it was only 2.76 and in the Webster orchard .31. The comparative freedom from codling moth injury of the check trees in the Webster orchard has been commented upon above.

Comparative tabulation of codling moth results in three orchards 1915

TREATMENT	NO.	PERFECT	SCAB	LEAF ROLLER OR GREEN FRUIT WORM	CODLING MOTH, WORMY			
					Total	End	Side July	Side August
One spraying								
Total	34 492	14 060	17 193	3 726	3 502	147	3 119	427
Per cent	......	40.76	49.84	10.80	10.15	.42	9.04	1.23
Two sprayings								
Total	24 089	13 973	6 683	3 013	2 135	66	1 907	329
Per cent	......	58.	27.74	12.50	8.86	.27	7.91	1.36
Three sprayings								
Total	29 830	20 657	5 306	2 414	2 460	51	2 167	273
Per cent	......	69.24	17.78	8.09	8.24	.17	7.26	.91
Checks or unsprayed								
Total	7 049	1 212	5 337	680	1 456	328	1 374	376
Per cent	......	17.19	75.71	9.64	20.65	4.65	19.49	5.33

The comparative tabulation of the results obtained from the three sprayed plots and on the check or unsprayed trees, shows in the first place a somewhat uniform total yield from the plots in the orchards treated in the same manner, though as brought out above, in two of the orchards at least, there were considerable discrepancies between the plots receiving the different treatments. It will be noted on referring to the table, that the percentage of perfect fruit increases progressively with the number of sprayings from 40.76 in the case of one application to 58 for two applications, and 69.24 for three applications, there being a similar and related decrease in scab infection. The control of this fungus was the important factor in

increasing the percentages of perfect fruit. The results, so far as control of the leaf roller is concerned, are not illuminating, since for the plot receiving one spraying the infestation amounted to 10.80 per cent, that sprayed twice to 12.50 per cent and that receiving three treatments, 8.09 per cent. It is doubtful if these variations possess much significance and the probabilities are that they can be more easily accounted for by variations in the infestation of the different plots and unavoidable differences in treatment, rather than to the value of late applications for the destruction of this pest.

The codling moth data are worthy of special comment, since they show unmistakably the benefits resulting from one application just after the blossoms fall and the comparatively small returns following later sprayings. The percentage of wormy apples for the three plots sprayed but once, amounted to 10.15, while that for the plots sprayed twice was 8.86, and for that sprayed three times, 8.24. The difference between the plots sprayed once and twice was only 1.29 per cent in favor of the latter, while between this and the plots sprayed three times, there is a difference of only .62 per cent. These figures are not quoted for the purpose of discouraging second and third sprayings for the control of the codling moth, but rather to emphasize the value of the first treatment. We are still of the opinion that control not obtained with the application made just after the blossoms fall, can not be secured in any practical manner by subsequent treatments.

The past season was exceptionally favorable for the development of scab, and in the control of this disease we find ample justification for two or even three applications after the blossoms drop. These later treatments should, in our estimation, be given more for the purpose of controlling this fungus than as a check upon the codling moth, though it is by all means desirable to add poison to the fungicide for the purpose of destroying as many codling moth larvae and various leaf feeders as practical.

SIDE INJURY

Approximately nine-tenths of the wormy apples on the sprayed trees showed the typical blemish (plate 1) caused by the late-hatching larvae of the first brood. These come from eggs deposited on the fruit the latter part of June and early in July. The young larvae enter the exposed, smooth surface of the developing apple and excavate a shallow gallery having a radius of approximately one-sixteenth of an inch and frequently marked by a reddish or reddish brown spot. This is probably a manifestation of the leaf-mining

habit of the young larvae, recorded by a number of observers in relation to those hatching from eggs deposited upon the foliage. A few days after entering the fruit many of the larvae desert the initial point of injury and make their way to the blossom end. This tendency to forsake an apparently perfectly satisfactory shelter is probably an inherited one and is analogous to the action of the larva leaving the temporary leaf mines in the search for fruit.

Investigations relative to the prevalence of this type of injury show its somewhat general occurrence along the south shore of Lake Ontario and in the vicinity of Lake Erie, as evidenced by the following observations.

In an examination September 18th of a "tree-run" of greening apples in the packing shed of Mr H. B. Eaton of Youngstown and said to be below the average, the following conditions were noted: 589 apples were examined of which 73 showed a July side worm infestation, 2 a July and August side worm infestation, and 2 an August side worm injury.

In an Albion orchard a greening tree bearing fruit on one side and presumably unsprayed, had practically 99 per cent wormy, there being 2 to 4 or even 6 side injuries on individual apples.

Counts in two Waterport orchards were kindly made by Mr A. B. Buchholz of Albion and his data are as follows:

In the orchard of B. G. Wilson, 438 Hubbardston apples were examined with the following results: perfect, 345; side wormy, July, 69; side wormy, August, 4; green fruit worm, 22.

In the orchard of H. L. Brown, a lot of 529 Hubbardston apples gave: perfect, 468; end wormy, 0; side wormy, July, 34; green fruit worm, 18.

Mr Brown sprays but once for the codling moth and usually has good results, though formerly he had considerable trouble with this pest. It has taken him several years to bring the insect under control. A later examination of over a barrel of "tree-run" Baldwins from Mr Brown's orchard resulted in finding 365 perfect apples; 58 scabby apples; 9 infested by leaf roller; 18 side wormy, the larvae having penetrated deeply into the fruit in 6 of these. Approximately a bushel of Baldwins from an old orchard belonging to Mr Brown was also classified with the following results: perfect, 75; sooty blotch or scab, 57; roller and scab, 1; end and side wormy, 1; side wormy, 3; side wormy, July, 19.

Mr J. B. Achilles made an examination of a sample lot of fruit in a Batavia orchard and tabulated his data as follows: perfect, 55; scab, 283; end wormy, 7; end and side wormy, 5; side wormy,

July, 27; side wormy, August, 28; green fruit worm, 13; total number of apples examined, 418. This orchard, it was stated, had been sprayed three times, arsenate of lead being used twice.

The orchard of Mr G. H. Rudman of Irondequoit, was examined and several heavily loaded Baldwin trees appeared to have an infestation which would compare favorably with conditions obtaining in the Webster orchard, though no precise counts were made.

An examination of a greening orchard at Charlotte showed a serious infection by scab and side injury which would probably approximate 20 per cent or over, a lot of 28 apples showing 1 injured by the leaf roller, 26 infected by scab, 1 end wormy and 13 side wormy.

One hundred king apples, " tree-run," from the orchard of Mr C. F. Kraus of Clarence, Erie county, were classified by Mr Strickland as follows: end wormy, 0; side wormy, July, 42; side wormy, August, 2; perfect, 56. This orchard had been sprayed once after the falling of the blossoms.

Again, 674 Baldwins from the orchard of Mr G. H. Wilder of Akron, Erie county, were classified by Mr Strickland as follows: perfect, 207; end wormy, 13; side wormy, July, 440; side wormy, August, 69; total wormy fruit, 468. It was stated that the trees in this orchard had been sprayed in the pink of the blow, again following the drop of the blossoms and two weeks after the blossoms fell, with lime-sulphur and arsenate of lead.

It will be seen by referring to this data from the different orchards, that side injury was not only prevalent but also rather serious in many orchards within 25 miles of the Great Lakes.

In this connection it may be desirable to add that in Mr Strickland's estimation one-fourth of the crop in many orchards in 1914 was marred by this characteristic side blemish.

The conditions in the western part of the State varied markedly from those obtaining in the Hudson valley. In the first place eggs were decidedly more common upon the fruit during July in Niagara county, it being comparatively easy to find one, two, three or even four upon individual apples while there were almost none upon the leaves, whereas at about the same time in Rensselaer county, recently deposited eggs and egg shells were more abundant on the foliage than upon the apples, there being two of the former to one of the latter. This latter was upon Siberian crabapples and the marked difference may possibly be explainable in part by the smaller size of the fruit.

The discrepancy in side injury is evident from the following data:

An examination of 97 Baldwins in the orchard of Mr Edward Van Alstyne of Kinderhook, just as the apples came from the tree,

resulted in finding only 12 showing side injury, and of these but 2 were probably entered to any depth.

An average run of greenings in the orchard of Mr John S. Baker of Muitzeskill gave 8 side wormy, 3 being inhabited, out of a total of 89 apples, 1 being end wormy.

Similar conditions prevailed in and about Poughkeepsie. For example, out of 33 Baldwin apples from the orchard of Mr Peter Cornell of Arlington, only 1 showed side injury, and an estimate in Mr Hart's Titusville orchard, based upon the fruit as it was brought to the packing shed, led us to place the side injury at less than 4 per cent, most of the damage being caused by the second or August brood. Very little codling moth injury was to be seen upon either old or young trees in the orchards of Mr Fred Pulling and Ernest Emans of La Grangeville.

Injury in well-cared for orchards in and about New Paltz was by no means excessive, and in the case of that of Mr A. E. Jansen the total infestation would hardly run over 3 per cent. The effective spraying in these localities for the control of codling moth is limited almost entirely to the one application just after the blossoms fall, though Mr Jansen states that he commonly makes two sprayings after blossoming, to spys and McIntosh, largely because of their susceptibility to fungous attack.

Somewhat different conditions were observed in a lot of picked apples belonging to Mr L. L. Morrell of Kinderhook. It was found, for example, in going over a barrel to obtain some perfect fruit for exhibition, that 40 apples out of a half barrel, approximately 20 per cent, were injured by codling moth. Some showed the characteristic end worm injury though by far the greater portion was due to the usual side worm injury of the Hudson valley, the pests working deep into the fruit and causing conspicuous scars. The trees from which these apples were obtained did not bear large crops and this may, to a certain extent, explain the relatively high percentage of wormy apples.

It is evident from an examination of these data, that side injury occurs to a more or less extent throughout the State and that the damage resulting therefrom is liable to be much more serious in the western apple-growing sections. It is also apparent from a study of the situation as a whole that fruit growers here and there, even in regions where side injury is very prevalent, are growing apples with a minimum of loss from insect damage.

We have had an opportunity of watching the actual spraying in different portions of the State and we are unwilling to admit

that it is impractical to control this pest or that failure to do so is due to carelessness in individual applications. We are also unable to see the necessity of making a later application, say the latter part of June, for the purpose of destroying the late-hatching caterpillars though a spraying at that time would probably help more in controlling the codling moth than a treatment given two or three weeks after blossoming. There is a practical difficulty in attempting to destroy these late-hatching individuals by spraying at about the time they are entering the fruit, because the apples are then growing rapidly and observations have shown that the period of entry may extend over two or three weeks, making it almost impossible to keep the expanding surface of the young fruit well covered with a poison.

OVIPOSITION AND EVENING TEMPERATURES

Side injury has been so marked in certain apple regions in the western part of the State that Mr L. F. Strickland, horticultural inspector stationed at Lockport, made records concerning oviposition and injuries caused by the young larvae.

These records we have compared with a series of evening temperatures calculated from minimum temperatures of Chatham, Wappingers Falls and Appleton, published by the United States Weather Bureau Service and corrected by adding thereto the difference between the minimum temperatures for the localities given and the mean hourly temperatures for Albany and Rochester based on a five-year record, 1891–95, kindly calculated and placed at our disposal through the courtesy of Dr P. C. Day, chief of the United States weather bureau. The Albany data were used for the correction of the Chatham and Wappingers Falls temperatures and the Rochester data for the Appleton records, the difference between the mean minimum of this period for June and July and the mean temperature at 8 p.m. being added to the recorded minima, this correction amounting for June and July for Chatham and Wappingers Falls, to 8° and 9° respectively, while for Appleton the difference was 9° and 10° respectively.

July 2, 1912 Mr Strickland records that codling moth larvae were entering the sides of apples in Mr John Garbott's orchard at Johnsons Creek, adding that almost every apple was entered at the side and that it was by no means necessary for another apple or leaf to touch. At that time very few unhatched eggs were observed, and on referring to the corrected evening records for Appleton, we find that the thermometer reached 60° or over on the 15th to the 17th, on the 20th and 21st, and from the 24th onward there was a

six day period when the evening temperature was above 60°. It is quite probable that the eggs referred to above were deposited mostly during the last of June.

Again, in 1913 he made the following record dated July 3d: " Not many side worm eggs." On the 8th he observed that a few larvae had entered the apples and that scattering eggs were also to be found. On the 19th he states that this late side injury seems to be distributed over a period of time, adding that unhatched eggs were still found and that most of the larvae entered the sides of the fruit. Referring once more to the calculated evening temperatures for Appleton in June 1913 it will be observed that they rose to 60° or above on the 13th to the 17th inclusive and that there was another period of moderately high evening temperatures from the 25th to the 30th inclusive, the latter continuing to the 10th of July. This long period of warm evenings was undoubtedly favorable to a protracted oviposition.

In 1914 the first codling moth eggs were found by Mr Strickland June 25th, and on referring to the calculated evening records for Appleton it will be noted that there was a period from the 8th to the 14th when the mercury stood above 60°, while from the 15th to the 20th it ranged below this figure, and from the 21st onward above, this latter apparently coinciding closely with the deposition of numerous eggs as noted above. The former warm period was probably a little early for the laying of many eggs. Later, in connection with apple inspection work, Mr Strickland recorded a very large proportion of side injury in Niagara county, in some instances this amounted to nearly 20 per cent of the barreled crop. In his judgment red fruit, especially Baldwin, king, wealthy and spy, was most seriously affected.

Very few codling moth eggs were found by Mr Strickland June 14 and 15 of the past season, and on the 28th and 29th he observed a few freshly laid eggs. On referring to the calculated evening temperatures for Appleton, it will be seen that the mercury was at 60° or above on the 13th to the 15th and did not remain at this point and above for a series of evenings until the 30th, while on July 8th large numbers of eggs were found by Mr Strickland in the orchard of Mr W. Briggs of Olcott, and Mr W. H. Cowper of Newfane. They were almost all unhatched, though nearly ready to disclose larvae, a condition indicating oviposition at about the time the rise in evening temperatures occurred.

Low evening temperatures could easily check the deposition of the eggs without greatly hindering the growth of the tree and such

appears to be the case. Consequently the apples become more conspicuous and smoother by the latter part of June or early in July, at the time when most of the eggs responsible for this type of injury are laid and there is a reversal of the usual habits of the moth, in that she then deposits, as shown by our observations, more eggs upon the fruit than upon the leaves. There appears to be no good reason why the recently hatched caterpillar should attack the smooth surface of the fruit, except that it is impelled by hunger and it naturally begins to feed soon after issuing, in this instance attacking the smooth surface of the fruit and causing material loss instead of the better known and comparatively harmless mining of the foliage.

Evening temperatures corrected from minimum records, 1912–15

	June	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Chatham . .	1912	52	62	72	65	59	59	57	43	49	52	57	58	54	46	54	63	70	59	53	66	72	62	58	60	70	74	57	64	73	56
	1913	55	65	52	65	55	60	72	51	42	43	49	54	58	67	56	73	73	52	56	65	73	65	59	64	70	68	76	71	57	61
	1914	63	54	52	63	55	66	70	69	64	64	61	64	61	59	62	58	47	56	60	48	50	65	63	73	73	62	66	67	64	63
	1915	53	59	54	54	54	57	70	58	57	62	58	68	58	71	65	68	70	72	69	67	57	58	62	58	56	63	71	56	60	75
Wappingers Falls	1912	66	60	69	66	60	57	58	54	56	52	66	68	60	54	58	63	60	68	70	66	62	67	70	73	75	70	69	70	77	64
	1913	67	70	56	68	57	60	69	57	50	49	53	57	60	70	65	70	75	62	60	67	70	67	63	67	72	70	69	70	59	64
	1914	70	54	55	55	60	50	54	70	66	66	66	62	69	60	62	57	55	57	55	54	55	66	67	77	74	68	64	70	66	66
	1915	53	57	57	48	53	61	70	73	60	62	61	69	60	70	70	70	73	70	70	67	60	56	63	58	54	63	64	56	66	70
Appleton . .	1912	61	67	66	64	54	52	55	45	53	52	57	63	53	49	66	69	62	58	52	65	62	55	57	64	67	69	63	63	75	59
	1913	59	56	53	54	48	58	59	51	53	47	54	58	62	66	66	69	62	57	55	53	63	52	59	59	68	80	71	72	62	66
	1914	65	55	61	55	53	48	58	76	73	79	66	71	64	61	56	57	51	50	59	48	62	63	64	74	71	61	67	60	61	60
	1915	53	60	58	51	52	62	64	59	51	56	60	54	60	63	63	59	61	57	66	62	56	62	56	55	63	61	55	56	61	70

Evening temperatures corrected from minimum records, 1912–15 (*concluded*)

	July	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Chatham....	1912	51	63	66	78	80	77	77	74	78	74	78	76	74	78	78	78	64	78	71	53	68	72	55	53	54	68	59	58	72	70	63
	1913	79	77	66	77	80	82	64	55	65	74	58	64	71	65	60	60	62	72	60	64	62	76	77	75	66	58	77	78	77	71	67
	1914	54	66	64	63	64	66	63	71	73	73	74	69	70	67	69	75	80	78	65	54	55	57	59	69	72	68	65	68	61	62	59
	1915	73	72	66	78	72	66	59	65	73	66	73	66	65	69	70	76	81	71	79	69	68	66	67	68	66	68	75	64	77	70	84
Wappingers Falls......	1912	56	63	69	71	85	75	75	81	79	79	82	81	78	81	78	81	73	81	78	58	71	70	63	61	60	71	63	62	71	71	64
	1913	81	79	69	81	79	81	66	64	71	73	61	63	74	71	63	63	71	70	78	77	67	66	71	70	71	60	66	74	81	76	74
	1914	57	68	67	66	67	69	65	69	71	75	73	73	77	71	69	78	79	74	68	59	64	61	62	71	73	71	71	69	61	63	59
	1915	73	68	71	72	71	65	60	70	59	65	65	68	64	68	71	74	77	69	71	72	69	67	67	64	61	61	71	64	77	72	79
Appleton.....	1912	50	60	74	76	78	76	76	77	77	80	78	70	70	78	77	68	65	65	65	57	67	68	67	66	63	69	70	66	76	70	59
	1913	83	72	67	72	76	66	65	60	68	68	57	64	70	60	59	60	72	71	65	69	63	58	59	73	59	60	67	78	73	73	66
	1914	62	68	64	60	69	67	67	72	74	73	73	76	77	77	75	74	81	70	65	57	72	71	74	73	74	76	73	69	66	60	62
	1915	69	67	70	64	70	64	65	67	63	67	73	70	73	70	74	76	77	67	74	64	63	64	60	61	71	72	64	67	74	74	78

SUMMARY AND CONCLUSIONS

A general survey of the conditions in the apple belt of the western part of the State shows that some growers are able to obtain practically worm-free apples with one spraying for the codling moth, others with two or three applications, while many suffer great losses in spite of frequent and apparently thorough treatments. We believe that practically all these conditions can be found throughout the belt. It logically follows that if one man can control the pest, his neighbor should be able to do equally well, and the difference depends largely upon the thoroughness with which the work is done. It is no easy matter to control this pest effectively, especially during seasons when many eggs are deposited late in June and early in July. The peculiar habits of the young apple worms hatching from late-deposited eggs, make it very difficult to destroy many by late spraying, and consequently freedom from side injury one season is determined in considerable measure by the treatment of the preceding year. We can hardly expect, under conditions prevailing in the western part of the State, to clean up badly infested orchards in one season. It will require two and possibly more. Generally speaking, unsatisfactory results are due to some deficiency or weakness in the treatment which can be eliminated only by careful search for the weak point.

The first spraying for the codling moth, the treatment just after blossoming, is by far the most effective application which can be made for controlling the pest.

The presence of abundant " side injury " is a most potent argument for thorough annual sprayings for the codling moth whether the trees be fruiting or not. This may be unnecessary where " side injury " is not serious as, for example, in the Hudson valley.

The second spraying for the codling moth would probably be more effective in reducing " side injury " if it were made the latter part of June, though so far as checking this pest is concerned, it does not seem to be essential.

Both the second and third sprayings for the codling moth, even if they have comparatively little influence in reducing the numbers of this pest, are abundantly justified in localities where scab is more or less prevalent, assuming, of course, that a fungicide is universally added to the poisoned spray.

CHRYSANTHEMUM MIDGE

Diarthronomyia hypogaea H.Lw.

Specimens of badly infested chrysanthemum plants were received under date of March 27, 1915 from Prof. R. H. Pettit of the Michigan Agricultural College, accompanied by the statement that this midge was causing serious injury in the houses of a commercial chrysanthemum grower at Adrian, Mich. A few plants accompanying this communication were so badly swollen and distorted by the numerous galls upon the leaves and stems that it was evident they could not develop normally and were therefore practically valueless. This was followed by the reception the latter part of September, of both galls and adults from Arthur Gibson, first assistant government entomologist, Department of Agriculture, Ottawa, Canada, and from Prof. E. O. Essig, Berkeley, Cal., indicating that the species, a European form, had become established in at least three widely separated American localities. The pest has also been received from Oregon.

Injuries. The damage is caused by a small, reddish midge about one-fifteenth of an inch long, which deposits its eggs upon the developing plant, the type of damage depending largely upon the time and manner of infestation. An abundant deposition of eggs upon young plants 3 to 5 inches high may result in greatly enlarged, irregularly swollen stems (these sometimes being twice their normal diameter), deformed rudiments of leaves caused by an arrested development, and a failure to produce blossoms, the plant making an ill-shaped head.

A less serious infestation, especially if this occurs after the plant has secured a good start, may result in a few comparatively insignificant swellings or galls on the stems, the presence of similar growths, frequently rather scattered (plate 13) on the leaves and more or less deformation of the flowers. Professor Pettit has found the galls on leaves, stems, buds and calyxes, though no plants coming into our hands have borne affected flowers.

Food plants. This insect has been recorded from central and southern Europe as infesting Chrysanthemum leucanthemum, C. corymbosum, C. atratum, C. japonicum and C. myconis, the first named, at least, being deformed as seriously and as variously as described above for the cultivated chrysanthemum in this country. It was first noticed in America on the variety known as mistletoe. Most cultivated chrysanthemums appear to be susceptible though, owing to the apparently local habits of the midges, the infestation is apt to be very uneven.

Recognition characters. The injuries briefly described above are the work of small maggots, which are pale greenish while young, later showing the characteristic yellowish or yellowish orange color of gall midge larvae. These irritate the tissues and produce irregular, ovoid swellings, each with a length of about one-twelfth of an inch and very frequently projecting at a rather marked, oblique angle above the normal surface of the affected tissues. A series of these galls side by side result in irregular, confluent swellings.

One of the easiest methods of detecting the young, inconspicuous galls is to allow the leaf to slip through the loosely closed fingers, a process which will readily disclose the presence of slight swellings. It is particularly desirable to recognize even the smallest galls if an attempt is made to eradicate the insect in a greenhouse, since the transformations occur within the plants. The small developing gall appears as a slight, nodular elevation with a darker center protected to some extent by an unusually abundant mass of short, white hairs, while the fully developed gall has comparatively few of these short hairs and the discolored apical portion makes it relatively conspicuous. The deformations containing insects nearly ready to escape may be recognized by the small, withered, discolored, free tip. Scattering galls may occur almost anywhere along the stem, on the petiole of the leaf, on the leaf surface, along the veins of the leaves, and occasionally at the very tip of a lobe.

Technical description. *Egg.* Reddish orange, length .15 mm, diameter .03 mm, the extremities narrowly rounded.

Gall. An irregular, oval, concolorous swelling (plate 13) with a length about 2 mm, usually at a distinct angle to the surface of the plant tissues and frequently causing large, confluent swellings of the stem, leaf or flower head.

Larva. Length 1 mm, yellowish or yellowish orange when full grown, moderately stout, the extremities rounded; segmentation distinct and the skin smooth.

Pupa. Length 1.25 mm, stout, narrowly oval, the cephalic horns distinct, conical, the thorax yellowish orange, the wing pads fuscous in pupae nearly ready to transform, the leg cases dark yellowish brown, the abdomen a variable orange, narrowly rounded apically.

Male. Length 1.75 mm. Antennae nearly as long as the body, sparsely haired, fuscous yellowish; 17 or 18 segments, the fifth with a stem about three-fourths the length of the subcylindric basal enlargement, which latter has a length about twice its diameter and a rather thick subbasal whorl of long, stout setae; terminal segment variable, usually somewhat reduced, irregular, elongate, ovate. Palpi; the first segment subquadrate, the second narrowly oval. Mesonotum dark brown, the submedian lines yellowish. Scutellum and postscutellum fuscous yellowish, the abdomen mostly a pale yellowish orange. Wings hyaline, costa light straw, halteres yel-

lowish transparent. Legs a pale straw, the pulvilli a little longer than the long, slender claws, the latter with a long, slender tooth basally. Genitalia; basal clasp segment moderately long, stout; terminal clasp segment short, stout, with a distinct spur; dorsal plate short, deeply and roundly emarginate, the lobes short, broad, obliquely truncate apically; ventral plate short, deeply and roundly emarginate, the lobes rather long and tapering to a narrowly rounded apex.

Female. Length 1.75 mm. Antennae extending to the third abdominal segment, sparsely haired, fuscous yellowish; 16 or 17 segments, the fifth with a stem about one-third the length of the cylindric basal enlargement, which latter has a length a little over twice its diameter; terminal segment reduced, sometimes compound and tapering to a narrowly rounded apex. Palpi; the first segment subquadrate, the second subconical and with a length a little greater than the first. Mesonotum fuscous brown, the submedian lines, the posterior median area, the scutellum and post scutellum mostly fuscous yellowish, the apex of the scutellum narrowly fuscous. Abdomen reddish orange, apically fuscous yellowish, the ovipositor about one-half the length of the body; terminal lobes short, broad, broadly rounded and sparsely setose apically. Other characters practically as in the male.

Life history. This insect, like allied greenhouse species, probably breeds continuously when conditions are favorable and presumably displays a marked preference for buds or tissues just unfolding from the buds. The transformations of this midge occur within the gall and it is probable that hibernation or aestivation may take place either in the adult or possibly as larvae in slowly developing, subterranean, presumably root stalk galls.

April 13, 1915 a number of infested plants were received from Michigan, a few midges emerged the following day and others were observed in the cages from day to day until the 26th. April 27th several males and females were put on a clean plant at about 10 a.m., and at 2.35 p.m. two females were observed investigating various leaves; one appeared to be much agitated and repeatedly thrust her long, slender ovipositor among the leaf hairs along the surface of the leaf. An examination of this leaf under a three-fourths inch compound objective revealed an elongate, oval, pale orange egg lying on the surface, almost horizontally and nearly completely hidden by the overlying leaf hairs. One female found dead in a cage had attached to her a string of extruded eggs, there being over forty and possibly nearly fifty, and on examination under a high power, streaming movements were observed in certain of the eggs, which lead us to believe that the egg stage is probably twenty-four hours or less. Owing to unfavorable conditions it was not possible to carry the insect through a life cycle, though the probabilities are

that this latter, as in the case of the allied rose midge and Hessian fly, may be completed in four weeks or less.

Observations in a commercial greenhouse show that the insects are comparatively inactive during the winter when temperatures are kept low (about 50 degrees), but as the houses warm up in the spring the pests become more active and a serious infestation may prevail for a time. This seems to be followed by a quiescent period which probably persists through the summer and then there is a resumption of activities in the fall, since rather badly infested plants and emerging flies were again to be found about the middle of October. Plants growing outdoors appear to be relatively free from infestation.

Distribution and future probabilities. This species has been recorded from central and southern Europe and, as stated above, it has already become established in several widely separated localities in this country, probably by the shipment of infested plants or cuttings. It was very likely brought to America without the normal quota of parasites and for a time at least it may prove to be a somewhat difficult insect to control, though it would seem as if the native parasites of our large and varied gall midge fauna might in time prey most successfully upon this midge.

Control measures. It is desirable to ascertain the present distribution of the chrysanthemum midge in America, and growers of this popular flower would do well to adopt every reasonable precaution to keep their stock free from the insect, especially since it lives also upon the common white daisy, Chrysanthemum leucanthemum, a widely distributed, introduced weed which would probably mean the persistence of the insect in a locality once it becomes well established, with presumably more or less perennial infestation and injury to cultivated chrysanthemums.

Badly infested plants should be burned (they are practically worthless) and it is possible that by cutting off and destroying the infested portions of others, it may be practical to exterminate the insect in greenhouses without resorting to more drastic measures. Fumigation with hydrocyanic acid gas has been practised by one large grower with considerable success, and so long as this treatment was given nightly the infestation was comparatively light, though if for any reason it was impossible to fumigate, midges were likely to be numerous the next day. Data at hand incline us to believe that this treatment can hardly be considered as more than repressive, and on that account we would emphasize the desirability of starting with clean stock and adopting every reasonable means to avoid infestation.

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WHITE GRUBS

The white grub outbreak of last season, predicted the preceding fall, was very serious in southern Rensselaer and northern Columbia counties in particular, though the damage was mitigated to a considerable extent by an unusually copious and well-distributed rainfall during the summer months. Grasslands, including both old pasture and recently seeded ground, were badly infested though the damage was more restricted and " spotty " than in 1912, probably due in part to the activity of natural enemies and partly to the unusually vigorous growth of grass at the time the grubs were feeding most actively.

There was also in this connection serious injury to susceptible crops planted on land badly infested by young grubs. In some instances this was so severe as to result in the practical loss of 30 to 75 per cent of the potato crop (see plate 12). Fodder corn, and especially field corn, was also seriously damaged.

Collections of adults in various sections of the State in 1914 clearly show that Lachnosterna fusca Froh. is by far the most abundant and injurious species in the upper Hudson valley, though L. fraterna Harr. was somewhat numerous. The most destructive species on Long Island, as evidenced by these collections, were L. hirticula Knoch. and L. tristis Fabr. These beetles resemble each other so closely that there is little probability of most

[1] Not available for reference.

people attempting to distinguish the various species. Fortunately they are so distinct from other insects that there is little danger of their being confused therewith, and so far as practical considerations are concerned, there is small need to distinguish between the closely related forms, since all have very nearly the same habits. The feeding of these beetles, while rarely seriously injurious to affected trees, may be taken advantage of to some extent to indicate the approximate amount of injury which may be expected from the grubs the following season.

Preventives and remedies. The three-year life cycle of these pests and the marked tendency of the beetles to deposit their eggs in the more luxuriant adjacent grass, makes it comparatively easy to anticipate injuries, especially if some attention is paid to the amount of feeding by the beetles upon forest and other trees. It should be remembered that damage by the beetles precedes by approximately twelve months the most severe injury likely to accompany the feeding of the grubs.

Again, the eggs are laid in June and in September or early October small white grubs one-fourth to half of an inch long are readily found about grass roots and usually within three inches of the surface of the soil. Land badly infested in this manner should be plowed as soon as possible, disked once or twice and, if practical, fowls or hogs allowed to run over the ground for a time and destroy many of the pests. Such land should not be planted with potatoes, corn or other susceptible crops. Small grains, especially rye, buckwheat, clover and vetch, may be sown and if the seeding is early enough it may be possible to avert the damage which would normally occur the following season if nothing were done. Land in good cultivation at the time the beetles fly is rarely badly infested by eggs though occasionally grubs may work into such ground from adjacent strips of sod such as that lying along a fence or the margin of another field.

Land badly infested with grubs one-half to three-fourths grown, the condition obtaining in the fall of 1915 in many localities, may be planted with susceptible crops in the spring of 1916 with a moderate degree of safety if the planting is delayed until the early part or possibly the middle of June, since at about that time the grubs will have largely ceased feeding.

The extended life cycle of these pests and their restriction to grasslands make it apparent that systematic rotation of crops is one of the most important preventive measures that can be employed. A rotation which does not allow land to remain in sod for more than two or three years, if generally followed in a neighborhood, will

reduce the danger of serious injury to a minimum. Such a rotation is also in accord with good agricultural practice.

The danger of losing crops when corn, potatoes or strawberries are planted upon recently turned, infested sod should be more generally recognized. The small white grubs are, as pointed out above, by far the most dangerous and it is by no means difficult to recognize them either in the fall or in the spring just before planting time, since they have practically the same appearance as when larger. The serious consequences following planting upon such land is due mostly to the great reduction in the number of plants to the square yard and the inevitable concentration of the grubs upon those allowed to grow. There is nothing to show that white grubs migrate to any extent, that is, more than a rod or two through the soil. Susceptible crops, if they must be put on infested land, should be fed liberally and cultivated thoroughly in order to assist the plants to outgrow the partial destruction of their roots.

GRASSHOPPERS

The outbreak of last year continued through the present summer and in some localities was very severe, though in most sections, especially where active measures were adopted in 1914, the injury was relatively light. Our investigations the past season were confined largely to Fulton and Saratoga counties. The lesser red-legged grasshopper, Melanoplus atlanis Riley, was by far the most destructive species, as was the case the year before, though there was some injury by the two-striped grasshopper, Melanoplus femoratus Burm., a species easily distinguished by its larger size, greenish or yellowish brown color and the two distinct yellowish lines on the back.

The infestation in Fulton county was decidedly less than that of the preceding year, due in large measure to the wholesale poisoning of 1914. At our request an examination of this section was made in early June by Mr P. M. Eastman of the Department of Agriculture. He found in the vicinity of Union Mills, especially near Clipp Hill, large numbers of grasshoppers and so far as he could learn very little poisoned bait had been used in that section last year. The wild country in and around Meco, and also west of Gloversville and extending beyond Garoga, was badly infested, which was also true in a similar section 2 or 3 miles beyond Berkshire toward Broadalbin. His investigations in the vicinity of St Johnsonville and Middlesprite resulted in finding relatively few of the insects, though certain residents of the latter place had feared a serious outbreak. The

consensus of opinion in and about Broadalbin, as disclosed by investigations by Mr D. B. Young the last of June, was that grasshoppers were not nearly so numerous as they had been last year.

The infestation in Saratoga county, a section where relatively little poisoned bait was used last year, appeared to be decidedly more serious than in Fulton county. Young grasshoppers appeared in early May and an examination made the 12th of that month on the farm of Mr Daniel Brown of Malta, showed a rather abundant and general prevalence of the insects on land which had been allowed to lie fallow for several years. There were at that time few or no grasshoppers in adjacent cultivated fields. Mr Brown stated that he had used some poisoned bait last year and was undecided as to what to do the present season. There was a more serious infestation on the farm of Mr Charles H. Carr in the town of Wilton, the young grasshoppers being so numerous that it was comparatively easy to count from twenty-five to fifty on a square foot, though this by no means represented average conditions. Mr Carr's land is in a sandy region adjacent to elevated, sandy knolls, the latter being badly wind-swept and showing numerous "blowouts." Last year Mr Carr found it necessary to use poison as many as three times on some fields and even then his vegetable garden was practically destroyed. Both he and Supervisor Clarence C. Smith were of the opinion that the insects flew readily, rising in swarms and repeatedly devastated certain fields. The farm of Mr Daniel McNeil, also of the town of Wilton, was rather badly infested, though the conditions did not seem to be so serious as those on Mr Carr's place.

Just outside of Saratoga on the farm of Mr George A. Supportus, and in sections nearby, there was an exceptionally severe infestation. This was so marked on the place of Mr W. H. Harris that although he had put out poisoned bait three or four times in certain areas, and in spite of the fact that he thus destroyed hosts of the grasshoppers, others drifted in from adjacent fields the latter part of July after the grass was cut and there was serious injury to asparagus, rhubarb and celery.

A bad state of affairs prevailed in and about the farm of Mr Stark Dake of Greenfield Center. Mr William C. Wilsie estimated that he had at least fifty acres which were badly and generally infested and on Mr Dake's farm there was approximately one hundred acres in this condition. Mr Dake estimated that there were in that section between three and four thousand acres badly infested with grasshoppers.

Development and habits of the pest. Small numbers of first stage lesser red-legged grasshoppers, the preeminently destructive species, were found in sandy places at Karner on May 11th and had apparently hatched only a day or so before, since they were by no means well colored. Young grasshoppers were most abundant on the edges of a "blowout" where the soil was sparsely covered with vegetation. Most of them were about three-sixteenths of an inch long, one or two being possibly one-fourth of an inch long. The next day many small grasshoppers, mostly well colored, were to be found in sandy situations at Malta. Hatching of the eggs by no means occurred at the same time and in some instances this may mean the appearance of several lots or swarms at irregular intervals covering a period of two to three or possibly four weeks. The young grasshoppers display a marked partiality for clover, defoliating or partly skeletonizing this first and then attacking various grasses. Infestations in new seeding are such as to suggest that the insects may have originated from eggs deposited in the firmer grass sod along the fences. May 27th the young grasshoppers were one-fourth to one-half of an inch long, and on June 17th most of the pests were half grown, a few winged ones, perhaps one-tenth of one per cent being observed. Pairing had already commenced. By the latter part of the month practically all the insects had developed wings.

The two-striped grasshopper is a later developing species than the lesser red-legged grasshopper, yet in spite of this, one light-colored nymph about three-eighths of an inch long and recently hatched was observed at Karner on May 11th and was probably one of the earliest of this species. Observations of last year show that most of the nymphs develop considerably later than is the case with the preceding species.

Natural enemies. Grasshoppers are subject to attack by a number of natural enemies, most of which escape ordinary observation and a detailed discussion of them would therefore not be particularly serviceable in this connection. We do, however, wish to place on record two observations.

At Corinth June 22d, Mr D. B. Young captured a species of Chalcis, as it was attempting to oviposit in a third stage grasshopper.

A large, predaceous wasp, S p h e x i c h n e u m o n e a Linn., was observed July 23d at Saratoga, flying about holes, some three-eighths of an inch in diameter, in a barnyard, and at least one of these wasps was seen carrying a grasshopper. This species is one of our well-known forms and in sections where it is abundant, usually

sandy situations, it very probably is of material service in destroying grasshoppers.

Control work. The very successful poisoning of last year was confined almost exclusively to fully developed grasshoppers and it was considered advisable to determine by practical field tests, the efficiency of various baits for the destruction of the young. This work was done in cooperation with the State Department of Agriculture and the Saratoga County Farm Bureau. The sodium arsenite mixture was prepared according to a formula recommended by Prof. F. L. Washburn, state entomologist of Minnesota, which is as follows: 3 pounds of sodium arsenite, $1\frac{1}{2}$ gallons of molasses, and 180 gallons of water. This preparation was applied May 27th to a new seeding of clover and timothy, clover predominating, on the farm of Mr Charles H. Carr of Wilton, and badly infested with young grasshoppers one-fourth to one-half of an inch in length. The day was cold and the insects were rather inactive. Fifteen to twenty-five could easily be counted on a square foot. The clover next to the road was nearly destroyed, the leaves being badly ragged. The application began at about 10.35 a.m. and was continued until early afternoon, the more thickly infested portion being sprayed twice, since one treatment resulted in using only about 26 gallons to the acre. Where possible, the spraying should be gauged to apply about 50 gallons to the acre. Many of the grasshoppers jumped on the recently sprayed clover and remained apparently feeding or drinking up the minute particles for several minutes at a time. The mixture has a pungent molasses odor and seems to be very attractive to the insects.

An examination about 1 p.m. of the next day resulted in finding a number of dead grasshoppers in the clover patch, especially in that portion which received the two sprayings. The hoppers were so small and the debris so abundant that some care was necessary in order to recognize the insects. A number of sick ones were also observed here and there.

On June 2d it was found that from three-fourths to nine-tenths of the young grasshoppers in that portion of the clover field which had been sprayed twice with the arsenate of soda had succumbed to the poison and fewer, probably 50 per cent, had been killed in the part sprayed but once.

The arsenite of soda was also applied on the afternoon of May 27th about 4 p.m. on the margin of a sparsely grassed field where young grasshoppers were very abundant. This was for the purpose of testing the effect of the preparation under totally different conditions.

An examination the next day, the 28th, disclosed a very few dead grasshoppers and some sick ones. On June 2d it was evident that there had been a marked reduction in the pests, although comparatively few dead ones were found. This was probably due in part to the absence of shelter and also to the abundance and activity of ants.

This poison can be quickly and economically applied with a potato sprayer and in fields abundantly infested with young grasshoppers, especially if there be considerable clover, it is perhaps the most satisfactory method of destroying the insects. The dilution of the poison is such that it is not dangerous to either plants or stock if used as directed, though precaution should always be taken to prevent cattle from feeding freely in sprayed fields immediately after the treatment.

The Kansas bait is one of the most satisfactory poisons for half-grown and larger grasshoppers. The following is the formula generally recommended: 1 pound of Paris green, 20 pounds of bran, 2 quarts of cheap syrup or molasses, 3 oranges or lemons, 3½ gallons of water. The bran and Paris green are thoroughly mixed while dry, and if large quantities are to be used it is important that the men preparing the bait should protect the nostrils with a moistened sponge and avoid breathing the poisoned dust. The juice of the lemons or oranges should be squeezed into the water and the remaining pulp and peel chopped fine or run through a meat grinder and put in the water and the syrup added. The poisoned bran is then well dampened or mixed with the liquid and when prepared should be moist and sufficiently mealy so that it can be easily sown broadcast. The quantity given above is sufficient for five acres.

This bait, prepared as directed above, was distributed along badly infested fence rows at about 8.30 a.m. May 27th, and an examination at 4 o'clock that afternoon resulted in finding no dead insects. The next day, about 4 p.m., numbers of dead and sick grasshoppers were to be found in and near the poisoned strip, and on June 2d remarkably satisfactory results were observed. In one area of approximately 3 square inches, eighteen dead grasshoppers were counted, while in another of about one-fourth of a square foot, eighty dead were found. It was estimated that fully nine-tenths and perhaps 95 per cent of the young grasshoppers had been destroyed during the preceding six days. The Kansas bait, especially in a sparsely grassed, badly infested area, gives somewhat more satisfactory results than the arsenite of soda preparation.

The coarseness of the Kansas bait resulted in our mixing up a small lot and substituting therein middlings for wheat bran. This was applied May 27th about 5 p.m. in a lane and also in a field where the young grasshoppers were moderately thick. An examination the next day resulted in finding some dead insects, though this modified form of the bait was decidedly more difficult to sow evenly and tends to bake in rather hard masses. These undesirable features made it impossible to advise the use of this bait, though there is a chance that some other modification might be advantageous.

Attempts to destroy young grasshoppers are not always so successful as those outlined above, and we are satisfied that by no means all failures can be explained in the same way. In the first place, the young grasshoppers are so small that it is very difficult, without more careful search than the ordinary farmer will give, to find the dead ones and, as a consequence, the efficiency of the treatment is greatly underestimated. Secondly, the prolonged period of hatching or the appearance of several different lots or swarms from approximately the same area, might easily lead to an erroneous conclusion as to the value of the poison. It is very probable, especially in the case of fields where there is an abundance of clover, that the young hoppers feed less freely upon the bait than in places where there is comparatively little attractive vegetation. It should be noted that our best results in destroying young grasshoppers with the poisoned bait were obtained where the grass was very thin. Furthermore, weather conditions have a material effect upon the activities of the young insects, and if the poison is put out during a cold or rainy spell, the chances of the pests eating much for several days, are decidedly small. Finally, in the case of the young grasshoppers, it seems advisable to make a fairly uniform and fine distribution of the bait in order to bring it within easy reach of as many of the insects as possible and where there is an abundant vegetation we would urge putting it out early in the morning at the time the young insects begin feeding for the day. Studies conducted by Messrs Webster and Urbahns in Massachusetts, show that apparently better results in destroying young grasshoppers may be secured if more fruit is added to the formula and they advise the use of six, rather than three lemons.

The poisoning of the young insects, although somewhat more difficult than the destruction of the larger grasshoppers, is the most economical method of controlling these pests. It is usually possible to kill very large numbers of them in comparatively restricted areas and, best of all, before there has been any material damage to crops.

These considerations, we believe, justify giving special attention to methods of destroying the young grasshoppers, even if it be necessary to distribute bait or spray with a dilute poison two or three times in order to accomplish the desired end.

The work of last year and that of the past season have abundantly demonstrated the practicability of killing the full-grown grasshoppers by the use of the Kansas bait, directions for the preparation of which are given above. If for any reason it is impossible to check the pests while young, the best we can advise is systematic and thorough distribution of a poisoned bait, making, if necessary, several applications in order to prevent serious damage. We are still of the opinion that grasshoppers are sufficiently local in habit so that the inaction or refusal to cooperate on the part of one or more will not as a rule seriously mitigate the benefits accruing to those who make timely applications of the poison, though there is no question that hearty cooperation of all in regions subject to grasshopper invasion is highly desirable.

MOSQUITO STUDIES

The region in and about Sodus bay presents peculiar conditions, in that there are within 3 miles of Sodus Point, as shown by surveys made by the Pennsylvania Railroad, about 220 acres of practically lake-level swamp, some 60 of these being in the immediate vicinity of the village. There has been more or less trouble from mosquitoes for some years, and in September 1914 the Entomologist was called into consultation by the Sodus Bay Improvement Association. A preliminary survey was made which resulted later in practical field work during June, July and August of the past season.

On the recommendation of the Entomologist, Mr H. H. Stage of Crittenden was engaged to do the actual field work, the Entomologist, owing to the peculiar conditions obtaining, directing and supervising. The undertaking was primarily practical in nature, though it was deemed advisable to secure accurate biological data in regard to the more annoying forms at least, since knowledge of this kind is necessary if the best results are to be secured, consequently Mr Stage was directed to familiarize himself thoroughly with the entire section and to make systematic collections in typical localities as well as to watch for the appearance of large numbers of larvae and see that they were destroyed by an application of oil before it was possible for them to mature.

The relation existing between the lake and the swamp made it impractical to attempt draining, and the large area of lowland rendered filling out of the question because of the expense involved.

The information gained in connection with the preliminary survey of September 1914, indicated a probable variation in the number and presumably the variety of annoying mosquitoes. There is a local belief to the effect that mosquitoes are much less numerous at periods of low water, which is very probably true. An examination of the monthly mean record of water levels, obtained through the courtesy of the Federal Government, shows that there has been during the past eight years, a variation in lake level of three and one-half feet. This, it will be seen at once, might have a marked influence upon the production of mosquitoes, and it is probable that some species are more troublesome during periods of high water, while others are annoying forms at times of low water. These changes in conditions and their effect upon the mosquito fauna are of practical value in any attempts to control the insects, and for that reason studies such as have been conducted the past season should be continued for a series of years for the purpose of obtaining exact information as to mosquito breeding under the varying conditions. There is also, aside from the influence of high water, more or less modification in habits and abundance of the various species, due to purely climatic changes.

The most serious menace to comfort appears to lie in the relatively small, swampy areas in and about Sodus Point and, to a less extent, in the extended cat-tail and sedge marshes in and about Second and Third creeks in particular, and possibly the considerably larger area south of Port Glasgow. The bearing these latter have upon the problem of mosquito annoyance can be determined only after more data have been secured relative to the breeding and flight of the irritating mosquito, a species which depends for its air supply upon the roots of aquatic plants, especially cat-tails, and one which would very probably find greatly increased opportunities for multiplication during seasons of high water.

The most practical outcome of the work of the past season is the demonstration that mosquitoes, even under very unfavorable conditions, can be controlled to a considerable extent at least, at a very moderate expenditure. In the case of this somewhat unusual problem, one man devoted his entire time for three months to the work and applied less than seven barrels of oil, this treatment being restricted to areas where larvae were actually found in considerable abundance. The cost of the entire work was less than $250. By far the greater number of communities in the State are not confronted with any such serious problem, and therefore a considerably smaller expenditure should give very satisfactory results.

At the inception of the work we made the following tentative recommendations:

Burn over the sedge and cat-tail areas in the winter so as to make the swamps more open and facilitate cutting, if that be advisable, the following season.

Eliminate, so far as possible, the small, permanent pools in the residential section. A very little filling will greatly reduce the possible breeding areas and much work of this character could legitimately be charged to real estate improvement rather than to mosquito control.

Supplement the burning in winter by cutting the sedges and cat-tails, so far as practical, the last week in May.

Follow this up by oiling, using a fairly heavy fuel oil wherever wrigglers appear to be abundant.

By no means were all these recommendations adopted, though some of the cat-tail areas were burned, and in the vicinity of the residential section there was more or less filling, nevertheless the comparative freedom from mosquitoes was apparent to all, and it may be stated in general terms that the work was highly satisfactory to those best situated to pass thereupon.

BIOLOGICAL OBSERVATIONS

BY E. P. FELT AND H. H. STAGE

This portion of the work was based partly upon personal observations by the Entomologist and largely on the field work of the junior author, who collected the specimens and transmitted them to the office for identification, together with data respecting their occurrence and abundance.

The most annoying species, as will be seen by referring to the following accounts, are probably the irritating mosquito, Mansonia perturbans Walk., the large meadow mosquito, Aedes abfitchii Felt, the woodland pool mosquito, Aedes canadensis Theo., and the swamp mosquito, Aedes sylvestris Theo., all forms likely to breed in numbers and become more or less troublesome in and about dwellings. The golden-scaled mosquito, Aedes aurifer Coq., occurs in large numbers in woodland swamps and fortunately rarely leaves its native haunts. Of the long-tubed mosquitoes, the house mosquito, Culex pipiens Linn., and the little black mosquito, Culex territans Walk., are probably the most important, though the white-dotted mosquito, Culex restuans Walk., may sometimes be nearly as abundant as the house mosquito. These three forms breed in standing, frequently artificial collections of water, though the little black

mosquito appears better adapted to swamp conditions and, as a consequence, it is sometimes present in much larger numbers than the others. It may become a serious nuisance because of its ability to pass through the ordinary mosquito netting. In addition to the fifteen species noticed below, we have records of two others occurring in and about Sodus Point, namely Aedes magnipennis Felt, a species which was found breeding in a temporary pool and is probably not particularly annoying, and also the small Uranotaenia sapphirina O.S., an interesting and practically harmless form.

Malarial mosquito (Anopheles punctipennis Say). Larvae and adults of this well-marked form were met with in small numbers during June, July and August. The larvae, as is well known, occur most frequently in grassy pools, while the adults are rarely abundant enough to be troublesome.

Fringed-legged mosquito (Psorophora ciliata Fabr.). This giant mosquito, easily recognized by its brownish black color, the bands of upright black scales on the femora and the white banded legs, was taken in July and August, though it was by no means abundant. This species is beneficial rather than injurious, since the larvae prey upon the wrigglers of other mosquitoes. The adult, though it bites, is rarely troublesome.

Large meadow mosquito (Aedes abfitchii Felt). Specimens of this common, rather large mosquito were taken in and about swamps, frequently in association with the golden-scaled mosquito, Aedes aurifer Coq., from June 16th to July 22d, they being particularly common in the boggy swamp east of Lake Bluff. Occasionally at least, this species is troublesome about houses, though only one specimen, in the course of the season, was taken upon a porch. This spring form breeds rather abundantly in open, grassy pools, the larvae being associated with other early species and occurring as late as July 10th.

Woodland pool mosquito (Aedes canadensis Theo.). Larvae of this medium-sized mosquito, easily recognized by the tarsal segments being banded at both extremities and the posterior segment of the hind tarsi being white, were taken in stagnant water in a small swamp near the village. Adults were captured July 20th at Third creek. The species does not appear to be particularly abundant or troublesome.

Brown woods mosquito (Aedes subcantans Felt). Larvae pupae and adults of this species were taken the latter part of August

though only in small numbers. It does not appear to be a particularly troublesome form locally.

Swamp mosquito (Aedes sylvestris Theo.). This medium or small mosquito has the tarsi narrowly white-banded basally. It was taken the latter part of June, during July and also in August, mostly in and about swamps, especially at First and Second creeks and Wintergreen point. Larvae were extremely abundant on Sand point August 14th following heavy rains, and were also found at this time in the large swamp area near the village. Under certain conditions this species is probably very abundant and annoying.

Golden-scaled mosquito (Aedes aurifer Coq.). This medium-sized, black mosquito with its conspicuous golden yellow scales on the sides of the thorax, is preeminently a woodland swamp form and was found abundantly under such conditions from June 7th to July 22d, it being particularly numerous in and about Lake Bluff swamp, though it was also found in a large swamp near Sodus Point village and in the vicinity of Second and Third creeks. This mosquito is one of the most bloodthirsty, attacking quickly and in numbers whenever there is an opportunity, though on account of its being limited so closely to sylvan conditions it is not troublesome to any extent in and about human dwellings.

Aëdes impiger Walk. Larvae of this common native species were taken in temporary pools in early July near Sodus Point, though in no case were they very abundant. This species appears to breed largely in small, temporary, woodland or swamp pools in association with A. canadensis and the series of species usually occurring under such conditions. It does not appear to be particularly important as an annoying form.

Three-striped mosquito (Aedes trivittatus Coq.). Two specimens of this mosquito were taken July 26th on Newark island. The adults have three black, longitudinal stripes with a yellow background on the thorax, while the legs and beak are unbanded. The wings are unspotted and the abdominal segments have lateral, basal white marks, which frequently unite to form transverse bands. This woodland form is reported as a fierce biter. It appears to fly low most of the time, since attacks are usually confined to the lower extremities, it rarely biting above the knees.

Tree Hole mosquito (Aedes triseriatus Say). This is another comparatively rare mosquito which breeds very largely in tree holes, hence its common name. A few larvae were met with August 24th in a characteristic depression near Second creek.

The adults are medium sized, the legs and beak black, the abdomen with white lateral patches basally on the distal segments, and the thorax with the lateral areas covered with long, silvery, grayish scales. The species is too rare to be of economic importance.

Aedes absberratus Felt & Young. One specimen doubtfully referred to this species was taken at Lake Bluff July 15th, presumably in a swamp inhabited by Aedes aurifer and A. abfitchii.

House mosquito (Culex pipiens Linn.). Larvae and pupae of this common species were found during June, July and August, being taken mostly in dirty or stagnant water, and particularly in water barrels, in one instance being found in a tree hole which was also inhabited by the tree hole mosquito, Aedes triseriatus Say.

The house mosquito breeds so generally in artificial collections of stagnant water near human dwellings that it should be comparatively easy to prevent its occurrence in great numbers.

White-dotted mosquito (Culex restuans Walk.). This common species is closely related to the house mosquito and, like it, breeds in artificial collections of water. Adults and larvae were taken in July and August, though at no time in such abundance as to warrant ranking this form as a pestiferous one.

Little Black mosquito (Culex territans Walk.). This is a small, black species which may be easily recognized by the white bands at the apex of the abdominal segments. The larvae are found almost everywhere in running or stagnant waters, though usually not abundant in that which is foul. Larvae and pupae were taken during June and July, adults being found the last of the latter month. Breeding appears to occur as in the related house mosquito and whitedotted mosquito, throughout the warmer part of the year.

The collections of the past season failed to demonstrate an unusual abundance of the adults, though larvae were frequently taken. Statements regarding conditions of earlier years, however, indicate that this species is frequently sufficiently abundant to constitute a real nuisance. The dark color of the adults in connection with their ability to make their way through ordinary mosquito netting, leaves little doubt that this species is occasionally exceedingly numerous and troublesome.

Dyar's mosquito (Culex dyari Coq.). This rare species, first taken at Center Harbor, N. H., was met with in the larval form June 8th near Second creek, only one specimen being taken. It is apparently an early spring form which rarely becomes abundant and is therefore of very little economic importance.

Irritating mosquito (Mansonia perturbans Walk.). This large species is easily recognized by the strongly contrasting colors, especially the broad, white band near the middle of the beak and the similar bands on the legs, the broad one on the posterior tarsi being characteristic. The abdomen is distinctly white-banded at the base of each segment and the wings with their large, white and dark-colored scales have a somewhat peculiar, mottled appearance.

Adults of this species were first observed on the wing June 14th and continued to fly till August 30th. A recently emerged adult, indicated by its nearly perfect condition, was taken on that date at Lake Bluff. The continuance of small numbers of adults, even later in the season, is probable, since a full-grown larva was taken at Wintergreen point August 31st. This species appears to be one of the most troublesome in that locality, as illustrated by collections on Sodus Point July 15th, at which time some twenty annoying mosquitoes were captured and every specimen was found to be of this species. These mosquitoes were rather numerous near the large swamp (25.8) just on the edge of the village. Again, July 23d, collecting on Eagle island near the center of the bay and remote from any suitable mosquito-breeding area, resulted in the capture of this species, and on visiting the south shore between First and Second creeks every mosquito captured proved to be this species. Similar conditions obtained on the evening of July 27th at Lake Bluff, except that a specimen of another species, Anopheles punctipennis, was also taken. The evening was especially favorable for mosquitoes, being rather warm and with little or no breeze. This species is well known as one of the fiercest and hardest biters. It enters houses readily and has very likely been responsible for much of the annoyance caused by mosquitoes in and about Sodus Point.

The tendency of this species to fly or drift some distance with the wind is indicated by the capture of specimens referred to above on Eagle island and also the finding of numbers at least half of a mile from any floating cat-tails.

It has been well known for several years that the larvae of this mosquito are peculiar in that they do not come to the surface but rely upon the collections of air in the roots of various aquatic plants. The wrigglers or larvae are easily distinguished from those of all other native mosquitoes by the strongly tapered, acute air tube which is thrust into the roots of cat-tails, Typha latifolia, and also the water loosestrife, Dococon verticillatus. It is possible also that they may live upon the roots of some other plants,

though so far we have not been able to demonstrate this. Full-grown larvae and pupae were found July 7th at Wintergreen point, attached to the roots of aquatic plants. Some idea of the abundance of this species may be gained from the following data: July 10th typical areas, each about 1 foot square, were examined and the results secured on five such plots are as follows: 6 larvae, 2 pupae; 8 larvae, 1 pupa; 2 larvae, 2 pupae; 4 larvae, 2 pupae and 1 larva, 4 pupae, respectively, an average of over 6 to the square foot. A similar examination made on the 10th resulted in the following data: 2 larvae, 3 pupae; no larvae or pupae; 12 larvae, 7 pupae; no larvae, 1 pupa; no larvae or pupae; 4 larvae, 2 pupae, respectively, an average of over 5 insects to the square foot. It is hardly probable that in any of these counts all the insects were secured and it is evident that comparatively small areas may produce enormous numbers of this annoying mosquito. The larvae and pupae were in all cases found only where the water was deep and with an abundance of debris covering the roots of the plants. Most of the areas were in the immediate vicinity of small pools, sometimes close to the main channel and almost invariably in connection with floating or semi-floating plants. The transformation of larvae evidently begins in early June, since pupae, pupal skins and recently transformed adults were found June 14th. At this time four recently-emerged adults with limp wings were taken from the surface of the water. It is probable that most of these insects complete their transformations between the middle of June and the middle of July, stragglers only issuing after this time. There is no reason for thinking that there may be more than one generation; the adults are presumably long-lived. Repeated examinations of localities where full-grown larvae were abundant up to and including early September, have been without results so far as finding young larvae is concerned, though they have been found upon the roots of aquatic plants by other observers.

An attempt was made to determine the possibility of preventing the development of this species by the application of oil, and a number of larvae and pupae well established upon cat-tail roots were put into a bottle and the surface covered with a film of oil. No insects were reared under such conditions, though a few were obtained from similar plants in water which had not been oiled. This test was repeated twice under practically the same conditions and it is very probable that judicious oiling, especially during the period indicated above, when the adults issue in large numbers, would be a very effective method of destroying the insects. Unfortunately we were unable to test this out under natural conditions.

AN OIL COMPOUND AND YOUNG TREES

Insect injuries to trees have been exceptionally serious during the last few years in the vicinity of New York City. This has been especially true of the hickory bark beetle, Eccoptogaster quadrispinosa Say, and the lined chestnut borer, Agrilus bilineatus Weber, and as a consequence various methods have been recommended for controlling these insects or destroying them after they have entered the trees. Observations have shown that it is possible to kill the young of the former insect by making applications of oils or oily compounds to the bark shortly after the adults have commenced operations, and there is a current belief to the effect that such treatment may also be a valuable deterrent to invasion. This has resulted in a number of preparations being placed on the market and widely advertised as effective against these pests and not injurious to the trees. There has been a natural tendency to use these compounds freely, and in some instances the outcome has not been what was expected. The following observations are placed on record for the purpose of showing the danger of the indiscriminate use of oil preparations upon the bark of trees, since if serious injury may develop within a few months upon young trees, it is reasonable to expect that damage may result, even if long delayed, in the case of those much larger.

The material upon which the following observations are based is an oily preparation which has been widely recommended under a trade name. A sample of the compound was secured and through the courtesy of the Honorable Edwin Duffey, State Commissioner of Highways, was examined in the laboratory of that department. The following is a transcript of the analysis:

Per cent water present	1.0
Homogeneous	Yes
Specific gravity	1.062
Per cent free carbon	0.23
Per cent distilling	110° C.–170° C. (light oil) 4.3
Per cent distilling	170° C.–235° C. (carbolic oils) 13.4
Per cent distilling	235° C.–270° C. (creosote oil) 9.9
Per cent distilling	270° C.–300° C. (anthracene oils) 45.2
Per cent pitch	27.2
Specific gravity of total distillate	1.022

Bureau of tests, by J. E. Myers, chemist.

Several red maple limbs with a diameter of approximately 1½ inches were cut March 2d, and after being rather thickly painted with this preparation, were set with the cut ends in jars of water to hinder evaporation so far as practical, and kept in a room at ordinary indoor temperatures. Two days later some penetration

of the inner bark, evidenced by a marked brownish discoloration, was apparent and ten days later, namely March 12th, there was an evident invasion of the compound, the inner bark and the outer portion of the sapwood being dark brown. At this time the untreated upper portion of the limb was green and normal, there being an abundance of sap in the inner bark and the sapwood, though there was some drying back at the very tip of the small branches. With a knife the outer bark was then carefully shaved from the entire stick in order to remove all the oily portion and thus show more clearly the condition of the inner bark and sapwood. This uncovered a series of plainly discolored areas having a transverse diameter of one-half to three-fourths of an inch, a length of an inch or more and extending frequently through the inner bark and into the sapwood. This shows clearly that under certain conditions an oily compound may penetrate the outer bark, pass through the inner bark and invade the sapwood. It is not claimed that this limb was under normal conditions and that therefore this result would invariably follow when such treatment was given to trees standing in the open.

This test was supplemented by applications March 8th to healthy forest trees standing in a location where there was no reason to suspect that unnatural conditions might influence the outcome in the slightest. The material was applied rather thickly from near the ground to a height of about 6 feet between 3.30 and 5.30 p.m. of a moderately warm, clear day, the sap in the sugar maples flowing abundantly. All the trees were so well protected by the surrounding growth that there could be no unusual exposure of trunk or branches to the sun.

Tree 1 was a sugar maple with a trunk diameter of $1\frac{1}{4}$ inches and a height of approximately 12 feet. On May 29th the bark was moist, greasy, and the leaves full size, though beginning to dry and presenting an unhealthy, brownish green appearance. This tree stood in a moderately open place so that the foliage received considerable light. The inner bark showed a brown discoloration in its outer layers and below a brownish green, unhealthy appearance. June 28th the tree was mostly dead, the inner bark was light brown and somewhat sappy. On November 10th the tree was dead save for some evidences of life at the very base and below the treated part. The oiled portion of the bark was brown and showed a distinct, dark line just beneath the surface. The tree had been entered by Ambrosia beetles, indicating an earlier, unhealthy condition.

Tree 2 was a sugar maple with a trunk diameter of $1\frac{1}{2}$ inches and a height of 12 feet. The bark was lightly scored with a knife just

before the application of the oily compound and the sap issued so profusely that it ran down and washed off the insecticide to some extent. On May 29th there was a more evident discoloration and to a greater depth than in the case of tree 1. The leaves were light green and apparently unhealthy, though the foliage was not so discolored as that of tree 1, due possibly to its being more sheltered from the sun. On June 28th the leaves were a light yellowish green though the inner bark was dark brown and lifeless and slightly moist with sap. On November 10th the tree was dead except the very base which was not oiled, and showed a more evident discoloration of the inner bark than in the case of tree 1. There were markedly deeper and more extensive stains in and near the wounds made just before the application of the insecticide.

Tree 3 was an ironwood with a diameter of about 1½ inches. On May 29th the inner bark was badly discolored, though the foliage appeared to be normal. On June 28th the leaves were light yellowish green, there being a perceptible difference between its foliage and that of other nearby treated trees. The inner bark was dead, dark brown and with little sap. On November 10th the tree was dead and the bark showed a marked discoloration to the sapwood. The treated portions were easily recognizable by the rich purplish brown color and the markedly greater fungous infection of the bark with a more or less evident discoloration extending into the sapwood.

Tree 4 was a hornbeam with a diameter of 1¾ inches. On May 29th both the inner bark and the foliage were apparently normal. On June 28th the inner bark was brownish green, though otherwise the tree appeared unharmed. On November 10th the tree was nearly dead and showed a plain and uneven discoloration in the inner bark. The treated portion had the bark plainly looser and the wood beneath showed a discoloration not evident in sections taken above the oiled part. Sections from the latter showed a moderately bright green condition quite different from that obtaining below.

Tree 5 was a white oak with a diameter of 1¼ inches. On May 29th the tree was dead and the inner bark was badly discolored, having a distinct oily odor. On June 28th fungus had begun to develop in spots here and there on the trunk. On November 10th a little sap was still evident at the very base of this tree.

Tree 6 was a hornbeam with a diameter of approximately 1½ inches. On May 29th it had partly leaved out and was dead, the inner bark being badly discolored. On June 28th fungus was developing in spots here and there on the base of the tree. On November 10th a little sap was evident at the very base of this tree.

Tree 7 was a red oak with a diameter of $1\frac{1}{4}$ inches. On May 29th the foliage was much retarded in development, the leaves being less than one-fourth the normal size and the inner bark showing a variable amount of penetration and injury. On June 28th one limb was dead and the leaves on the others were only one-half the normal size and pale green. The inner bark showed a little discoloration. On November 10th this tree was still alive though the oiled portion of the bark was manifestly browner and more discolored than that which was not treated with the insecticide.

Tree 8 was a red maple with an approximate trunk diameter of $1\frac{1}{2}$ inches. On May 29th the oil had penetrated the bark very little or not at all and the foliage appeared to be normal. On June 28th the foliage was yellowish green and possibly somewhat abnormal. The inner bark was hardly discolored. On November 10th this tree was alive though the bark showed a deep and marked discoloration in spots, in certain sections this evidently extending to the sapwood and in some instances probably into it, in somewhat the same manner as recorded above for the cut red maple limb.

Tree 9 was a large hornbeam with a diameter of about 2 inches. On May 29th there was very little evidence of penetration of the bark by the oil and the foliage appeared to be normal. On June 28th the inner bark was possibly somewhat discolored though the foliage was normal or nearly so. On November 10th the tree was alive though apparently with some discoloration of the inner bark.

Tree 10 was a large hornbeam with a diameter of 2 inches. On May 29th there was very little penetration of the bark by the oil and the foliage appeared to be normal. On June 28th the inner bark was possibly somewhat discolored and the foliage normal or nearly so. On November 10th there was apparently some discoloration of the inner bark by the oil.

It will be noted that six out of ten trees died within six months after the treatment and under conditions which hardly justify any other verdict than that of death as a result of oil injury. It is true that ordinarily much larger trees would be treated with this or similar preparations and therefore the probabilities of injury would be less, owing to the thickness of inert outer tissues which must be penetrated before the oil can invade the living and necessary vital cells of the inner bark and outer sapwood. It is well known that a heavy lubricating oil, the green grease of the machinist or the anthracene of the chemist is a very dangerous material to apply to the trunks of trees, and in a preparation containing such a high percentage of this

series of hydrocarbons as the one under consideration, we would rather expect injury, possibly serious, to develop some time after the treatment, possibly two to three years, much depending upon the species and the age of the tree. There is no question, for example, but that sugar maples are much more susceptible to oil applications than many other trees, and the data at hand indicate a much greater liability to injury in the case of the younger, thin-barked wood, be it the trunk of a young tree or the branches of older trees. The main point we wish to establish is that oils or oily compounds can not be used with impunity upon the bark of living trees, and that apparent freedom from damage for a season or two by no means indicates that all danger of injury has passed.

In this connection we would call attention to the case of two hickory trees which we examined in 1912. The trunks had been lightly coated with gas tar September 3d or 4th of that year for the purpose of determining its value in protecting the trees from invasion by the hickory bark beetle. Under date of October 22, 1914 we were informed that the trees had died and had been cut out in spite of the fact that prior to treatment they were two of the best trees on the estate. Others within 25 feet of those tarred were still in excellent condition, indicating that gas tar as well as certain oily compounds are inimical to the welfare of forest trees.

NOTES FOR THE YEAR

The depredations of the apple tent caterpillar, Malacosoma americana Fabr., have been severe in many localities, though the injury was not so general as in the preceding two years. The forest tent caterpillar, Malacosoma disstria Hübn., was also locally abundant and destructive, particularly in certain parts of Long Island.

There have been records during the last few years, of extended flights by the cotton moth, Alabama argillacea Hübn., a species unable to maintain itself in the north. It is interesting to record, in this connection, the capture of a specimen at Albany November 3d, on a cool day following two moderately warm ones. The moth was somewhat torpid but otherwise seemed uninjured.

A noteworthy capture of another southern species, the giant Erebus odora Linn., merits more than passing mention because twenty years have elapsed since a specimen of this insect was brought into the office. The species is recorded as being abundant in southern Florida and the warmer portions of the Gulf States.

FRUIT TREE INSECTS

Apple maggot (Rhagoletis pomonella Walsh). This species is becoming locally abundant in some sections of the State, especially in certain Hudson river localities, and as a consequence there is a keen interest in methods of control. The work of the pest is easily recognized by the irregular, brown, sometimes rotting channels in the flesh or pulp of the fruit. The insect displays a marked preference for the late summer and early fall varieties, though it also attacks winter apples. The evidence at hand indicates it to be a somewhat local form and while there may be some disagreement as to the best methods of controlling it, there is little question but that material benefit may be secured by the collection and destruction, through feeding or otherwise, of the late summer and early fall varieties twice a week and of the fall and winter varieties once a week. The object of this procedure is to destroy the maggots before they have had an opportunity of escaping from the fruit and entering the soil where they pass the winter within a few inches of the surface. Thorough cultivation is doubtless of value, since it produces conditions more or less unfavorable to hibernation.

The collecting of the fruit is obviously necessary only in the case of unusual infestations. It should be stated in this connection that there is some evidence to show that spraying with arsenical poisons for the destruction of leaf-feeding insects, especially the applications made about midsummer, appear to be somewhat effective in checking this insect.

Red bugs. The red bug (Heterocordylus malinus Reut.) and the lined red bug (Lygidea mendax Reut.) are both widely distributed in the Hudson valley and where unchecked have frequently inflicted serious injury upon the apple crop. The lined red bug appears to be the most numerous in this section, though the other species is also found in numbers.

Young red bugs were abundant in the orchard of Mr W. H. Hart of Arlington April 27th, some days before the Baldwin and greening blossoms opened. On April 30th investigations showed large numbers of the pests, four or five being found on individual blossom clusters, though this was distinctly above the average. The true red bug was at this time far more abundant, though some young lined red bugs were to be seen. The latter had evidently just hatched and were approximately one-tenth as numerous as the other species. Some of the true red bugs were even then approaching the second stage and evidently had been abroad some days. The young true red bug may be recognized in the first stage by its

bright red color, the black tip of the beak and its smooth body, while the young lined red bug is a grayish or slaty reddish brown, ornamented with numerous short, black hairs.

An application just before the blossoms opened, using one pint of tobacco extract, 40 per cent nicotine to 100 gallons of water, together with a lime-sulphur wash 1 to 25 and the usual amount of arsenate of lead, resulted in killing many of the small red bugs as well as protecting the trees from fungous infection and early leaf feeders. An examination of the trees sprayed in this manner showed a relatively much greater freedom from infestation than was secured in 1914 by nicotine applications after the blossoms had dropped. Observations the latter part of June showed that the earlier conclusions were by no means erroneous, since there was a gratifying freedom from infestation except in the case of a few trees which did not receive a nicotine application just prior to blossoming. These latter showed perceptibly more injury by red bugs.

The experience of the past season has demonstrated the advisability of watching closely for the appearance of red bugs and spraying early so as to destroy the insects before they have attained any size. In this connection the earlier signs of damage are of considerable importance and are indicated by an indistinct reddish brown spotting of the more tender opening or recently unfolding leaves. This discoloration has been compared to the appearance presented after a light dusting with red pepper. It is usually easy to find the small red bugs, only one twenty-fifth of an inch or so in length at this time, near the leaves showing the first signs of attack. As the injured leaves age the discoloration becomes somewhat darker and after a time the central portion of the more seriously affected tissues may die and drop, leaving an irregular series of reddish, brown-margined holes in the somewhat crumpled, curled leaves, very characteristic signs of earlier injury.

The earliest evidence of injury to the small apple is a slight exudation accompanied by a local discoloration and hardening. The young fruit is frequently pierced to the core and as growth continues, depressions with pithy centers extending deep into the tissue may be noted. There is usually a marked irregularity in the shape of the apple and many of those most seriously affected are dwarfed and drop about midsummer.

San José scale (Aspidiotus perniciosus Comst.). This pest has not bred very abundantly, as a rule, in the Hudson valley and examination last fall in unsprayed orchards which had been under observation for several years, showed that, if anything,

the insect was less numerous than two years earlier. This condition had evidently been brought about by natural agents, since in each of these orchards there had been no marked change in horticultural practices. There was no difficulty in finding the scales here and there, showing the characteristic circular holes made by the small parasites which have attracted so much notice in recent years, and the probabilities are that these tiny agents have been important factors in keeping the scale from multiplying unduly. In this connection it should be stated that none of these orchards are in what would be considered an ideal horticultural condition. The best of the trees are stunted, the foliage being rather small and with a deficient color, while most of them show a small to a considerable amount of dead wood.

There is nothing in the conditions recorded above which seem to justify the abandonment of spraying for San José scale, especially as the incidental benefits resulting from this application are, in our estimation, more than sufficient to cover the cost of the treatment. The parasites, if they are destined to have an important effect upon their hosts, will gradually become more abundant in the smaller, unsprayed orchards and here we may expect them to render their best service, since it is relatively more costly and difficult for the owner of a few trees to spray. The most that these scale parasites can do at the present time is so unsatisfactory that we believe they are practically unworthy of consideration by the commercial grower.

Sinuate pear borer (Agrilus sinuatus Oliv.). This destructive and extremely dangerous European borer became established in New Jersey some years ago and is now extending its range slowly in New York State where it is already known to occur in several localities. The parent insects are slender, shining, bronzy brown beetles about one-third of an inch long. They may be found on bright, sunny days on the trunk and branches, the female depositing her eggs in crevices and under slightly raised bark scales. The eggs hatch in early July and the slender, whitish grubs begin their narrow, winding burrows in the inner bark and the outer sapwood. The galleries of the young larvae have a markedly serpentine course and a width of one-sixteenth of an inch or less. A badly infested limb may show, upon the removal of the outer bark, series of these galleries winding back and forth and seriously interfering with, if not cutting off, the supply of sap. The early operations of this borer do not produce conspicuous swellings, hence limbs or even entire trees may be practically destroyed before there are marked, outward indications of the trouble, though as time advances the

older, sinuous galleries become very conspicuous, especially on the smooth bark because of an external, somewhat characteristic cracking. A sickly condition of pear trees, not readily explainable by known causes, should lead to a careful examination, since this borer may be responsible for the trouble. The death of large trees is usually preceded by a weakened condition and the gradual loss of limbs. The slender, white grubs, easily recognized by the larger, flat head and the pair of minutely toothed, brown, curved processes at the posterior extremity, require two years for their development and when full grown are about one and one-half inches long. The second winter is spent in the pupal cell, an excavation made at a depth of about one-fourth of an inch and connected with the bark by an exit gallery.

Badly infested limbs or trees should be cut out some time during the winter and destroyed prior to the latter part of May so as to prevent the escape of the contained insects. We are informed, through the courtesy of Prof. P. J. Parrott of the State Experiment Station, that recent studies by Doctor Glasgow have shown that the beetles feed readily on the foliage, which makes it possible that they may be controlled to some extent by the use of an arsenical spray the latter part of May or shortly before the beetles commence to appear.

Professor Parrott also informs us that he is experimenting with a deterrent wash composed of 60 to 80 pounds of lump lime, 2 pounds of copper sulphate and 100 gallons of water. The copper sulphate is dissolved and diluted with about 25 gallons of water, the lime is slaked, then run through a fine screen and diluted with the remainder of the water. The copper sulphate solution and the lime wash are then mixed together and the application made with a spraying machine. This wash or some modification should be thoroughly tested in orchards where the insect has become established.

It is perhaps needless to add that fruit growers in regions where this insect is not known, should exercise every reasonable precaution to prevent its introduction into uninfested orchards. It would be much better to destroy, unnecessarily, a number of trees than to take the chance of introducing such a serious pest.

Pear thrips (Euthrips pyri Dan.). Depredations by the pear thrips have continued in the Hudson valley and in some instances were exceptionally severe, the damage probably being much greater because of the unusual weather conditions. There was an early and extremely warm period which caused the pear buds to start very rapidly and gave the thrips an opportunity to enter. This was

followed by comparatively cool weather, accompanied by a slow development of the leaves and flowers, a condition favorable for severe damage by any insects which might have gained entrance to the buds during the warm weather.

The suddenness of attack by this insect is shown by the conditions observed in the orchard of Mr M. C. Albright at Athens April 17th. At this time there was a rather general infestation, the blossom buds had started a little and the thrips were making their way down into the center of the buds. It was easy to find blossom buds here and there on the lower branches with one to two or three thrips, and near the top of the trees, blossom buds with four to five insects endeavoring to enter were not at all uncommon. The pests were noticed for the first time, according to Mr Albright, on the 16th, and weather conditions were such that it would hardly seem as though they could have issued much earlier. This orchard, so far as known, was not injured to any extent by thrips the preceding year.

The sudden appearance of large numbers of the thrips is also borne out by conditions observed in the afternoon of the 17th in the pear orchard of Mr Robert McHench at Clarksville. This orchard lay at a considerably higher elevation, the difference between the Athens and Clarksville orchards being approximately 800 feet. The pear buds in the latter orchard were just beginning to start and there was no evidence of thrips above ground, though a few of the insects were observed in a pear orchard near the village of Clarksville and at a lower elevation, probably about 700 feet.

On April 24th the trees in this orchard had started perceptibly and in not a few instances two to four or even six thrips were to be found in the buds. The insects are able to make their way down among the bud tissues even when there is comparatively little breaking or spreading of the bud scales at the tips. Spraying was in progress at this time, a thin lime wash composed of 75 to 80 pounds of lime to 100 gallons of water, to which three-fourths of a pint of black leaf 40 was added, being used. Dead thrips were to be seen on the treated trees. The branches and wood were rather thickly covered with a lime wash, though the buds for the most part were not satisfactorily protected. The lime wash did not seem to adhere with any degree of thoroughness to the bud tissues after the scales had commenced to spread to some extent, though those which had hardly started at all were fairly well covered on one side, the other not being thoroughly protected and indicating a somewhat deficient spraying. The treatment in this orchard was delayed a little later

than desirable, owing to the difficulty of securing the spray materials and the necessary help. We believe that better results from the application of the lime wash would be obtained if the spraying is done before the buds have started appreciably, and under most conditions this would be comparatively easy, though last spring it was far from the case, due to the unusually early warm weather.

No other treatment was given in this orchard for pear thrips and the trees developed an exceptionally full bloom and set a large crop of fruit. This latter was reduced to some extent by an abnormally late drop which may have been caused by thrip injury to the stems, though subsequent observations showed a moderately severe psylla infestation in the orchard.

In addition to this injury, serious damage was observed in pear orchards at Milton and at Bangall. In the former the insects appeared in large numbers and nearly destroyed the Seckel bloom and there was serious injury to the Seckels at Bangall in spite of an early spraying with tobacco, due probably to the treatment being given a little too late. At the time of examination May 6th, white nymphs were rather numerous on one or two of the trees.

The developments of the past season have shown that a thick whitewash such as that mentioned above, is a valuable protective in warding off thrips attack, though the spraying should be done before the buds have started to any appreciable extent. Spraying with a tobacco extract, 40 per cent nicotine, is the best that can be advised for the destruction of the insects after they have appeared, and the notes given above emphasize the advisability of having everything in readiness so that the spraying can be done just as soon as the insects appear in numbers. Apparently they need only a little time in which to establish themselves within the buds, where they are comparatively safe from any application. It is practical, if many of the insects have escaped this first contact application, to spray just as soon as the young pears have separated sufficiently so that the insects at the base of the fruit stems are exposed, and a special effort should be made to drive the insecticide into all crevices of the fruit clusters. A third treatment with tobacco may be advisable after the blossoms fall, for the purpose of destroying the young insects. Four to 6 pounds of soap should be added to the tobacco preparation if the latter is not used with any other insecticide, to facilitate spreading, since this greatly increases the efficiency of the treatment.

Pear psylla (Psylla pyricola Forst.). This insect maintains itself as a serious pest in many pear orchards in the Hudson

valley, though outbreaks are usually very limited and are, as shown by observations of the preceding year, frequently closely related to unusually favorable winter shelters, such as nearby brush heaps, fences or stone walls and their accompanying weedy growths.

The temperature variations were so unusual and rapid last spring that it was exceedingly difficult to regulate spraying practices so as to kill the San José scale and destroy all the eggs and at the same time not injure the trees. Observations at Athens April 17th revealed numerous psylla eggs and a number of active adults, the latter probably still depositing eggs. The indications were that oviposition would be completed before the blossom buds had advanced so far as to make it unsafe to spray with the lime-sulphur wash at winter strength. The warm weather at this time, however, left a very narrow margin between the completion of oviposition and the development of buds to such an extent that it was unsafe to use the strong lime-sulphur wash.

Quince curculio (Conotrachelus crataegi Walsh). This insect is a serious pest and is not easily controlled. The practical difficulties are probably due to the marked variations in the appearance and development of the beetles. The late Professor Slingerland records that in 1896 adults appeared the last week in May, while in 1897 they did not begin feeding until about two months later or the last of July. Observations upon some infested quinces, in company with Mr L. F. Strickland at Newfane July 26th, showed that eggs and young larvae of this pest were rather abundant. Many of the quinces had been injured either by oviposition scars or feeding punctures, and the indications were that a considerable proportion of the fruit would be seriously damaged before the end of the season.

An examination the latter part of September in the quince orchard of Mr H. E. Wellman at Kendall, showed almost no injury from this pest, though there had been, according to statements by the owner, very serious damage the preceding year. He also added that the pest had been rather troublesome for a number of years. The past season he made three poisoned applications; one just after blooming, a second about two weeks later, and a third the latter part of July; in other words, he gave practically the same treatment as for the codling moth, and our observations failed to show any material injury from the Curculio, though there were a few places here and there where the adults had evidently eaten to some extent.

It is quite possible, in view of the erratic appearance of the adults, that the earlier applications were unnecessary, especially since recently laid eggs and young larvae were repeatedly found in that

section the latter part of July. It is probable that many of the insects succumbed to the last treatment. The evidence at hand indicates considerable protection from a poisoned spray, and the most economical and practical method of controlling this insect, with our present knowledge, would doubtless be to watch for the earliest feeding punctures and then spray thoroughly at once, and if this treatment be given early, make a second application a week to two weeks later, the greater delay being presumably advisable if the earliest feeding occurs the latter part of May.

Cherry leaf beetle (Galerucella cavicollis Lec.). This small, red leaf beetle was exceptionally abundant in Chautauqua, Cattaraugus, Erie and Niagara counties in particular, though it was also reported from some other portions of the State. It excited considerable attention and some apprehension because of depredations on peach and cherry trees, it displaying a marked preference for sour cherries. The feeding in most instances did not seriously damage the trees, though in some cases it amounted to partial defoliation. This is a common species in the Adirondacks, occasionally becoming so numerous as nearly to defoliate the somewhat abundant wild red cherry, Prunus pennsylvanica, frequently known as the bird, fire or pin cherry.

This outbreak is by no means unprecedented, since several similar though not such widespread depredations have been recorded by the late Doctor Lintner (11th Rep't, N.Y. State Ent., pages 197–98, 1896). This peculiar condition of affairs may have been due, in the opinion of Mr F. Z. Hartzell, to an unusual abundance of the beetles in connection with the general defoliation of wild cherry trees by apple tent caterpillars. The appearance of this insect in Niagara county, according to Mr J. B. Achilles, was preceded by about thirteen days of northeast winds, which suggests a possibility that the beetles may have drifted from the Adirondacks where they appear to be much more abundant than on wild cherry trees in the western part of the State.

This beetle, like other leaf-feeding insects, is susceptible to arsenical poisons, and experiments conducted by Mr Hartzell at Fredonia, showed that the trees could be protected if arsenate of lead was used at the rate of 4 pounds to 50 gallons of water and the application made to the lower as well as the upper surfaces of the leaves. The most satisfactory results are obtained when the poison is combined with bordeaux mixture. Tobacco extract, 40 per cent nicotine, will also destroy the beetles but affords no subsequent protection to the plants, since the volatile contact insecticide destroys only

those actually hit by the preparation. Small, badly infested trees can be protected by jarring the insects into pans containing a little kerosene and water.

FOREST TREE INSECTS

White pine weevil (Pissodes strobi Peck). The depredations of this well-known insect are becoming of increasing importance owing to its presence in large numbers in recent plantings. Two years ago last spring, after consultation with the Entomologist, Mr Waldo C. Johnston of Cooperstown began a systematic collecting of the weevils on fifty acres set with about sixty thousand young pines. The work was started a little late (about May 21st) and the trees carefully collected over four times at intervals of approximately four or five days each. At the outset two to four weevils were taken on a tree and toward the last only one or two insects for each row of about four hundred trees. The cost of these four collections amounted to $64 or only $1.28 an acre. An examination made in early July of that year resulted in finding very few insects.

Collecting along the same lines was continued during 1914 and the season of 1915. The latter part of last June Mr Johnston reported that they had been able to collect comparatively few weevils this past season and finally stopped work because a man would average only one to four weevils after a good day's work. These figures indicate a very large reduction in the numbers of the pests and presumably mean practical extermination and comparative freedom from injury for the entire planting.

This method possesses the decided advantage of being positive in action. There can be no question but that the weevils are destroyed, though the expense may be somewhat greater than that of collecting the infested tips or attempting to protect the trees by some spray application. It can be practised most successfully only on considerable areas of small trees, conditions where it is usually most desirable to check the pest.

Ugly nest cherry worm (Archips cerasivorana Fitch). The characteristic nests of this species were rather common in early summer on chokecherry in southern Rensselaer county in particular, and occasioned some apprehension for fear that the pests would extend their operations to other trees. A well-developed nest of this species was found June 16th by Mr C. B. Cutler at East Greenbush on Lombardy poplar, and on further examination it is presumable that the insects first defoliated some nearby chokecherry

bushes and then migrated to the poplar. There was a little feeding though by no means much upon this latter plant.

Dioryctria abietella Zinck. Specimens of the work of this insect were received November 4, 1915 from Mr G. G. Atwood, chief of the bureau of horticulture, who states that the specimens were from Austrian pines growing at Rochester, N. Y.

The buds, evidently young growth, have been badly tunneled by the caterpillars of this species, and in one recurved shoot, suggesting somewhat the work of Evetria bouliana, the remains of a caterpillar were observed. Irregular, rather coarse particles of reddish brown frass were attached here and there to the affected shoots and in one instance formed a mass half an inch long and about one-fourth of an inch broad. One woody twig with a length of 3 inches had been neatly tunneled by the borer, the gallery having a diameter of nearly one-eighth of an inch.

Periodical Cicada (Tibicen septemdecim Linn.). The appearance of this insect, more generally known as the seventeen-year locust, is always interesting, particularly if it occurs in large numbers. Brood six of the seventeen-year race has been characterized by Doctor Marlatt as "an unimportant scattering brood," and the published map showing its distribution indicates a wide range from the state of Wisconsin south to Georgia, with an evident concentration in western North Carolina, northwestern South Carolina and northern Georgia, and a secondary center ranging along the eastern boundary of Pennsylvania, through New Jersey into New York, where it has been recorded more or less authentically from Greene, New York, Richmond and Schenectady counties.

Mr William T. Davis of New Brighton states that though he has records from many localities it was nowhere quite so common in 1915 on Staten island as it was in 1881 or in 1898 and the distribution appears to be sparing. He reports the insect from the government reservation at West Point, Orange county, a new record, and a living specimen was received from Mr J. L. Livingston, Tivoli-on-Hudson, Dutchess county. Mr W. H. Hart and his nephew, Mr C. S. Hubbard, both reported having heard Cicadas in the town of La Grange, Dutchess county, and another gentleman at La Grangeville stated that he had also heard a few Cicadas in nearby woods. This is a locality where brood two, which appeared last in 1911, was exceedingly common and there is every reason for giving these reports full credence. There is also a statement by Mr D. V. Haggerty to the effect that this insect occurred in small numbers near Wiccopee, the extreme southern portion of the county. Further-

more, near the northwestern edge of Whaley pond and close to the tracks of the New England Railroad running from Poughkeepsie to Waterbury, Conn., the writer noted a group of oaks upon a knoll which, from the car window, gave every indication of having been injured by Cicada oviposition. These facts indicate a probable wide and sparse distribution of this brood in Dutchess county and it is possible that similar conditions may obtain in the wild regions on the western bank of the Hudson river though no definite reports were received. Correspondence with several New Baltimore persons failed to locate an infestation, which is also true of East Glenville, Schenectady county, a locality from which the insect had been reported in earlier years.

GRASS INSECTS

Grass webworms (Crambus luteolellus Clem.). The grass webworm depredations of last year have been continued this season, in one case a five acre field of corn near Pine Plains being destroyed by the insects. These pests, as has been stated before, live by preference upon grasses and ordinarily their depredations in cultivated fields are limited to portions adjacent to mowings or pastures or to crops planted upon badly infested, recently turned sod. The latter is due to the fact that the grass webworms pass the winter as partly grown caterpillars and when the sod is destroyed they must feed upon whatever else is allowed to remain upon the soil or perish.

There is no very practical method of fighting these pests, owing to the fact that usually severe injury is caused before their presence is suspected and then it is too late to do much to protect the remainder of the crop. In localities where webworms are liable to be abundant it is advisable to keep corn and other crops susceptible to attack at some distance from grasslands and to avoid planting upon recently turned sod. If land badly infested by these insects is plowed in late summer or early fall, say August or early September, many of the caterpillars would perish before the following spring. If this be impractical, spring plowing should be delayed as late as possible so as to give the caterpillars a chance to complete, so far as practical, feeding before the sod is turned under. The putting in of an extra amount of seed and liberal fertilization is also of service in enabling the crop to withstand any such injury. There is considerably less danger of serious infestation where a frequent crop rotation is the rule, which is another consideration in favor of good agricultural practice.

It is possible that many of the young caterpillars could be destroyed

by spraying badly infested grassland in early spring shortly after the young grass has started and at least a week before plowing, with an arsenical poison such as sodium arsenite at a strength recommended on page 60 for the destruction of grasshoppers. This could be applied very cheaply with a potato sprayer and where there is an infestation such as that mentioned above, might easily save replanting of the land and possibly a serious loss in yield.

Spittle insects. The white, foamy masses of "spittle" produced by these small insects are sometimes so common on timothy and other grasses as to result in serious injury to the crop. This was the case in several localities in Dutchess county the past summer. There are two rather common and widely distributed spittle insects in this State known as the lined spittle insect, Philaenus lineatus Linn., and the European spittle insect, Philaenus spumarius Linn. The former, so far as the State collections are concerned, appears to be much more common and abundant, occurring alike in the Adirondacks and in the lower Hudson valley. The full-grown insect is an inconspicuous, yellowish brown leaf hopper about three-sixteenths of an inch long and with a somewhat definite, yellowish line along the lower margin of each forewing when the insect is in the normal resting position. The European leaf hopper is a somewhat larger species, measuring a little over one-fourth of an inch in length and very similar in coloring, except that it lacks the rather distinct line mentioned above and bears somewhat indistinct, angular markings near the middle of the forewings. It seems to be more northern in its range, specimens in the State collection being from Adirondack localities only.

The young of both of these species are yellowish or yellowish green, rather stout and are usually found only by pushing to one side the white, foamy spittle, an excretion supposed to protect the tender, immature insects from the drying sun and wind and produced by the little leaf hopper literally beating air with its "tail" into a viscid excretion. The popular and, in some localities widely current, belief that young grasshoppers inhabit the frothy masses, is not supported by facts, the mature spittle insect being quite different from a grasshopper. The eggs are undoubtedly deposited in the stems or crowns of various grasses and remain unhatched till the following spring.

It is well known that old meadows are most liable to be badly infested by these insects. Knowing as we do that the young, with their limited powers of locomotion must hatch in the spring and

develop upon vegetation near at hand, it is easy to see that a frequent rotation of crops, incidentally a good agricultural practice where possible, is also a most efficient method of preventing these pests from becoming extremely abundant. Plowing either in the fall or moderately early in the spring must mean the destruction of millions of the young leaf hoppers.

There are conditions where a moderately frequent rotation of crops is inadvisable or impossible and for such cases we would suggest burning over infested meadows in late fall or preferably in early spring as the most promising method of destroying many of the eggs.

MISCELLANEOUS

Thelydrias contractus Mots. A number of peculiar larvae of this remarkable beetle were received from a New York correspondent, accompanied by the statement that they occurred in great numbers in the house and were found almost everywhere excepting in woolen garments or articles. They occurred in pasteboard boxes where there was apparently nothing to attract them, in perfectly clean garments, in clean muslin bedding and in almost everything covered with white tissue paper, in china closets, in a bookcase and also in a tool chest. The number of larvae sent indicated a considerable degree of abundance.

This sending is of more than ordinary interest, since it relates to an European species first discovered in this country in 1902, and one which may possibly become a pest of considerable importance in museums, probably in stored food products and perhaps in dwellings. The larvae resemble somewhat those of the Buffalo carpet beetle or Anthrenus except that they are considerably smaller in size and may be readily distinguished by the characteristic clavate hairs or scales. The studies of Mr L. H. Joutel of New York indicate that one year may be required to complete the life cycle. He has also ascertained that the larvae may live for three or four years without food and that they are unusually resistant to the fumes of carbon bisulphide. It is quite possible that this insect might establish itself in stuffed natural history specimens, such as birds, animal heads, etc., and from such breeding centers gradually spread throughout a building. The runways and nests of rats would also probably furnish attractive conditions.

Thorough cleaning of the infested rooms and the free use of sodium flouride was advised. This was done and a month later the correspondent reported a comparative freedom from the insects.

PUBLICATIONS OF THE ENTOMOLOGIST

The following is a list of the principal publications of the Entomologist during the year 1915. The titles,[1] time of publication and a summary of the contents of each are given. Volume and page numbers are separated by a colon.

Notes on Forest Insects. Economic Entomology, Journal, 1914, 7:373-75

Brief notes are given on the forest tent caterpillar, Malacosoma disstria, the apple tent caterpillar, M. americana, the spotted hemlock borer, Melanophila fulvoguttata, the two-lined chestnut borer, Agrilus bilineatus, and the hickory borer, Eccoptogaster quadrispinosa, with observations on the relation of drought to borer injury. A short notice of work with the white pine weevil, Pissodes strobi, is also included.

Borers in Trees. Tree Talk, v. 2, no. 2, p. 11-13, 1914

A popular article discussing several of the more important borers occurring in New York State and general methods of control.

List of Zoophagous Itonididae. Economic Entomology, Journal, 1914, 7:458-59

A list of twenty-nine species with observations on food habits.

Arthrocnodax constricta n. sp. Economic Entomology, Journal, 1914, 7:481

Description of a species preying on red spider in Porto Rico.

Cactus Midge, Itonida opuntiae Felt. Prickly Pear Travelling Commission, Report, p. 77, 78, 1914. Brisbane, Australia.

Summary account of life history and injuries.

Gall Midges as Forest Insects. Ottawa Naturalist, 1914, 28:76-79

A summary discussion of gall midges as forest insects and the description of Rhabdophaga swainei n. sp.

New Genera and Species of Gall Midges. U. S. National Museum, Proceedings, 1915, 48:195-211

A table for the separation of the genera in the Asphondylariae is given and the following new genera and species described: Microcerata buscki, Rubsamenia multinoda, Ctenodactylomyia n. g., C. watsoni, Xenasphondylia n. g., X. albipes, Proasphondylia n. g., P. braziliensis, Oxasphondylia n. g., O. re-

[1] Titles are given as published. In some instances articles appearing in a number of papers have been given different titles by the various editors.

ticulata, Asphondylia altana, Eocincticornia n. g., E. australasiae, Eohormomyia n. g., E. howardi, Scopodiplosis n. g., and S. speciosa.

Fumigation for the Box Leaf Miner. Economic Entomology, Journal, 1915, 8:94–95

Summary of experiments with carbon bisulphide, ammonia, naphthalene and potassium cyanide.

Mycodiplosis macgregori n. sp. Economic Entomology, Journal, 1915, 8:149

Description of a species reared from larvae preying on red spider on cotton.

Scurfy Scale on Norway Maple. Economic Entomology, Journal, 1915, 8:160

Records occurrence of Leucaspis japonica Ckll. on Norway maple and privet at Stamford, Conn.

Early Spring Pests. New York Farmer, March 18, 1915, p. 8; Catskill Recorder, March 19, p. 7; Buffalo Commercial, March 29

Brief practical accounts of the pear psylla, pear thrips, red bugs, apple tent caterpillars, and June beetles.

Report of the Committee on Entomology. New York State Fruit Growers, Proceedings, 1915, p. 28–35

A general discussion of entomological problems with special mention of San José scale parasites, the leaf roller, codling moth, apple maggot, red bugs, pear psylla, pear thrips, and the army worm and grasshopper outbreaks.

Red Bugs and Other Insect Pests in the Hudson Valley. New York State Fruit Growers, Proceedings, 1915, p. 180–86

Summary accounts are given of the red bugs, pear thrips and pear psylla, with mention of the raspberry Byturus and red spider.

Insect Outbreaks: Their Causes and Control. Western New York Horticultural Society, Proceedings, 1915, p. 51–58

A general consideration of the causes, possible prediction and prevention of insect outbreaks with special mention of the army worm and grasshopper devastations.

A New Chrysanthemum Pest. The American Florist, April 10, 1915, 44:612; Economic Entomology, Journal, 8:267; Tree Talk, v. 2, no. 4, p. 27

Brief descriptive account of the recently established Diarthronomyia hypogaea Lw. of Europe.

29th Report of the State Entomologist on Injurious and Other Insects of the State of New York, 1913 (issued April 15, 1915), p. 1–257, 16 pls.

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Remedies and Preventives for Plant Enemies and Diseases. The Ball Canning and Preserving Recipes, Edition F., p. 56–62, 1915

A comprehensive spray calendar for trees and small fruits.

Grasshopper Control in New York State. Economic Entomology, Journal, 1915, 8:227–29

Summary of results obtained with poisoned bait for the control of Melanoplus atlanis Riley.

Juniper Plant Bug (Chlorochroa uhleri Stal.). Economic Entomology, Journal, 1915, 8:308

Records injury to peas, corn, tomatoes and other garden crops and details observations on feeding habits and also those of Euschistus variolarius Pal. Beauv.

Apple Red Bugs. Catskill Recorder, May 7, 1915

Brief warning notice.

Seventeen-year Cicada. Catskill Recorder, June 25, 1915

The capture of a specimen in northern Dutchess county is recorded and a request made for specimens and data from other localities.

New North American Gall Midges. Canadian Entomologist, 1915, 47:226–32

The genus Kalodiplosis, with K. multifila as the generic type, is erected and the following new species described: Lestremia floridana, Microcerata aldrichii, Porricondyla wellsi, Asteromyia sylvestris, Kalodiplosis floridana and Hormomyia fenestra.

New Gall Midges. Economic Entomology, Journal, 1915, 8:405

The following species are described as new: Dasyneura torontoensis, Feltiella davasi, Mycodiplosis fungiperda, Parallelodiplosis corticis and Retinodiplosis palustris. One sex is described of Prionellus monilis and Asteromyia leviana.

A Breeding Record of Anthrenus verbasci Linn. Economic Entomology, Journal, 1915, 8:430

Records continuous breeding in dry corn for over thirteen years.

Pine Insects. Tree Talk August, 1915, 3:6

The white pine weevil, the pine bark louse and the pine leaf scale insect are discussed briefly.

White Grubs. New York Farmer, September 2, 1915, p. 8; Catskill Recorder, September 3

Summary account of injuries, with a forecast of probable damage another season.

New Asian Gall Midges. New York Entomological Society, Journal, 1915, 23:173–84

Two new genera, Xiphodiplosis and Androdiplosis, are erected and the following species described: Didactylomyia ceylanica, Microperrisia pulvinariae, Dentifibula ceylanica, D. obtusilobae, Mycodiplosis simulacri, Diadiplosis smithii, D. hirticornis, Xiphodiplosis fulva, Arthrocnodax rutherfordi, A. walkeriana, Lowiola costata, Androdiplosis coccidivora and Dyodiplosis generosi. A table for the separation of the males of Diadiplosis is also given.

The Gall Midges of the Pine. Brooklyn Entomological Society, Bulletin 10:74–76, 1915

A resumé of the habits and economic importance of the American species recorded from pine.

ADDITIONS TO COLLECTIONS, OCTOBER 16, 1914–OCTOBER 15, 1915

The following is a list of the more important additions to the collections:

DONATION

Hymenoptera

Abia inflata Nort., honeysuckle sawfly, larva on honeysuckle, July 6, G. A. Bailey, Geneseo

Trichiosoma tibialis Steph., Hawthorn sawfly, cocoon, March 4, J. H. Dodge, Rochester

Pontania hyalina Nort., gall on Salix fragilis, July 19, S. H. Burnham, Hudson Falls. Same, gall on willow, October 5, Mrs E. P. Gardner, Canandaigua

P. pomum Walsh, willow apple gall on willow, October 5, Mrs E. P. Gardner, Canandaigua

Kaliosysphinga ulmi Sund., European elm leaf miner, larvae and work on elm, June 26, C. I. Bucknam, West Newton, Mass.

Monophadnoides caryae Nort., larvae on butternut, August 20, Jannette W. Hill, Malden. Through State Department of Agriculture

Neuroterus umbilicatus Bass., galls on burr oak, July 19, S. H. Burnham, Hudson Falls

Holcaspis globulus Fitch, gall on oak, October 5, Mrs E. P. Gardner, Canandaigua

Amphibolips inanis O. S., empty oak apple, August 30, S. H. Burnham, Hudson Falls

Callirhytis futilis O. S., gall on white oak, S. H. Burnham, Hudson Falls

C. ceropteroides Bass., galls, April 15, R. S. Walker, Chattanooga, Tenn.

Andricus batatoides Ashm., potato gall, gall and adults on live oak, March 16, Ortego, Fla. Through Mrs E. P. Gardner, Canandaigua

A. excavatus Ashm., galls on Quercus velutina, S. H. Burnham, Hudson Falls

A. lana Fitch, woolly oak gall, November 16, H. E. Ruggles, St Paul, Minn. Same, gall on oak, October 5, Mrs E. P. Gardner, Canandaigua

A. petiolicola Bass., galls on oak, May 21, Walter Luke, Scarsdale

A. turneri Ashm., gall on oak, April, T. R. Baker, Winter Park, Fla. Through W. W. Yothers

Aylax taraxaci Ashm., gall on dandelion, S. H. Burnham, Hudson Falls

Rhodites dichlocerus Harr., long rose gall on Rosa blanda, S. H. Burnham, Hudson Falls

R. rosae Linn., mossy rose gall on rose, June 24, Miss Mabel Cooke, Lake George

R. fulgens Gill., gall, February 2, A. E. Stene, Kingston, R. I.

Megarhyssa lunator Fabr., lunate long sting, August 14, O. S. Edwards, Rensselaer

Vespa diabolica Sauss., yellow jacket, adults, July 20, Mrs E. P. Gardner, Canandaigua

Sceliphron caementarium Dru., mud dauber, nest, March 6, Mrs Horace L. Greene, Fort Plain

Coleoptera

Hylesinus opaculus Lec., dark elm borer, adult on elm, June 24, Mrs Walter A. Wood, Hoosick Falls. Through State Department of Agriculture

H. aculeatus Say, ash timber beetle, work on ash, January 18, S. H. Burnham, Hudson Falls

Eccoptogaster rugulosa Ratz., hickory bark beetle, adult and work on hickory, July 29, J. H. Livingston, Tivoli

Conotrachelus crataegi Walsh, work in quince, September 29, L. R. Simons, Mineola

Ceutorhynchus sericans Lec. var. and Rhinoncus pyrrhopus Boh., adults on pine, May 1, W. C. Johnston, Cooperstown. Same, L. T. Shumway, Cooperstown

Cryptorhynchus lapathi Linn., mottled willow and poplar borer, grubs and work on Carolina poplar, June 24, J. G. Sweigert, Plattsburg. Same, work and adults on poplar, July 19, John Dunbar, Rochester

Pissodes strobi Peck, white pine weevil, adult and work on pine, March 6, M. A. Brown, Delhi. Same, larvae and pupae on Norway spruce, July 7, J. A. Sweigert, Plattsburg

Epicaerus imbricatus Say, imbricated snout beetle, adult on grape, May 1, David Hunter, San Antonio, Tex. Sent with specimens of Fidia cana

Rhynchites bicolor Fabr., rose curculio, adults on rose, June 14, F. M. Rice, Albany

Pomphopoea sayi Lec., Say's blister beetle, adults on locust, June 21, J. A. Ennis, Pattersonville. Through State Department of Agriculture

Nacerdes melanura Linn., adults, July 20, J. E. Barkley, Albany

Diaperis maculata Oliv., larvae on Polyporus, September 9, S. H. Burnham, Hudson Falls

Coptocycla bicolor Fabr., golden tortoise beetle, May 31, L. R. Simons, Mineola. Same, on hickory, June 3, G. A. Lintner, Summit, N. J.

Chalepus dorsalis Thunb., locust leaf miner on locust, May 31, L. R. Simons, Mineola. Same, adult, August 11, C. H. Zimmer, Lynbrook. Through State Department of Agriculture

Galerucella cavicollis Lec., cherry leaf beetle, adults on sour cherry, June 24, F. J. Rose, South Byron. Same, on ornamental cherry, June 24, J. H. Dodge, Rochester

Diabrotica vittata Fabr., striped cucumber beetle, adults, June 21, J. O. Thompson, Jonesville

Fidia cana Horn, adults on grape, May 3, David Hunter, San Antonio, Tex.

Saperda concolor Lec., gall on poplar, March 30, S. H. Burnham, Hudson Falls

Phymatodes amoenus Say, work on Vitis riparia, April 22, S. H. Burnham, Hudson Falls

Callidium antennatum Newm., blue pine borer in rustic work, June 24, S. B. Ferris, Upper Saranac

Osmoderma scabra Beauv., rough flower beetle, adult, August 12, Miss Katherine D. Phelps, Canton

Euphoria inda Linn., bumble flower beetle, adults, May 21, D. V. Haggerty, Wiccopee. Same, on corn, August 31, A. M. Hollister, Saratoga Springs. Same, adults on maple, October 14, F. P. Bowles, Gloversville

Cotalpa lanigera Linn., goldsmith beetle, adult, June 9, T. F. Niles, Mount Kisco. Through State Department of Agriculture

Anomala lucicola Fabr., light loving grapevine beetle, adult, July 10, Benjamin Hammond, Garden City

Lachnosterna tristis Fabr., June beetle, adults, May 28, L. R. Simons, Mineola

Macrodactylus subspinosus Fabr., rose beetle, adults, July 10, Benjamin Hammond, Garden City

Hoplia sackenii Lec., adults on birch, June 29, Garden City. Through State Department of Agriculture

Photuris pennsylvanica DeG., fire fly, larvae, September 16, Mrs E. P. Gardner, Canandaigua

Agrilus otiosus Say, gall on Ostrya, March 30, S. H. Burnham, Hudson Falls

A. sinuatus Oliv., sinuate pear borer, work on pear, October 7, H. W. Merkel, New York City

Dicerca divaricata Say, divaricate Buprestis, adults, June 7, A. L. Kniffen, West Coxsackie

Agriotes mancus Say, wheat wireworm, larvae on corn, June 26, L. R. Simons, Mineola

Alaus oculatus Linn., eyed elater, adult, July, G. L. Flanders, North Chatham

Dermestes lardarius Linn., larder beetle, adult, August 7, Mrs H. G. Reist, Schenectady

Byturus unicolor Say, raspberry Byturus, adults and work on raspberry, May 12, C. G. Velie & Son, Marlboro

Thelydrias contractus Motsh., larvae, October 15, Miss Mary Darrow, New York City

Carabus nemoralis Mull., adults, May 6, Ward's Natural Science Establishment. Through State Department of Agriculture

Diptera

Culex sollicitans Walk., salt marsh mosquito, August 31, J. G. Livingston, New York City

Rhabdophaga aceris Shimer, maple leaf midge, larvae on soft maple, July 27, M. J. Adams, Rensselaer. Same, larvae and cocoons on soft maple, July 28, J. M. Ropes, Albany. Same, adult, August 24, S. B. Fracker, Madison, Wis.

R. batatas O. S., willow potato gall on willow, October 5, Mrs E. P. Gardner, Canandaigua

R. salicis Schrk., European willow stem gall, galls and adults on willow, July 3, A. Cosens, Toronto, Ont.

Dasyneura communis Felt, galls on maple, June 8, D. A. Ricker, West Springfield, Mass. Same, gall on sugar and soft maple, June 14, October 5, Mrs E. P. Gardner, Canandaigua

Diarthronomyia hypogaea H. Lw., Chrysanthemum midge, adult and gall, March 27, R. H. Pettit, Adrian, Mich. Same, larvae and galls on Chrysanthemum, April 13, October 9, 13, E. D. Smith & Company, Adrian, Mich. Same, adults and galls, September 24, E. O. Essig, Berkeley, Cal. Same September 25, Arthur Gibson, Ottawa, Can.

Phytophaga ulmi Beutm., elm bud gall, on elm, October 5, Mrs E. P. Gardner, Canandaigua

Rhopalomyia anthophila O. S., fuzzy goldenrod gall, on goldenrod, September 7, Mrs E. P. Gardner, Canandaigua. Same, galls on Solidago, September 29, S. H. Chubb, Kings Bridge. Through G. Clyde Fisher

R. fusiformis Felt, fusiform goldenrod gall on Solidago, September 19, G. C. Fisher, Leonia, N. J.

R. millefolii H. Lw., galls on Yarrow, October 2, E. Bethel, Denver, Col.

Walshomyia texana Felt, adults and galls on wild Texas cedar, Sabina sabinoides, October 4, Mrs L. T. Binkley, Austin, Tex.

Asteromyia carbonifera Felt, black blister gall on Solidago graminifolia, September 19, G. C. Fisher, Leonia, N. J.

Lasioptera clavula Beut., dogwood club gall on Cornus, March 19, Frost & Bartlett Company, Stamford, Conn.

L. corni Felt, ocellate leaf gall on Cornus, September 7, Mrs E. P. Gardner, Canandaigua

L. farinosa O. S., warty blackberry gall, October 5, Mrs E. P. Gardner, Canandaigua

Lasioptera vitis O. S., tumid grape gall, June 2, T. J. Headlee, New Brunswick, N. J. Same, gall on grape, August 12, H. G. Kirk, Harrisburgh, Pa.

Neolasioptera cornicola Beutm., dogwood stem gall on dogwood, March 30, S. H. Burnham, Hudson Falls

N. eupatorii Felt, snakeroot stem gall, September 7, Mrs E. P. Gardner, Canandaigua

N. hamata Felt, September 24, Mrs E. P. Gardner, Canandaigua

Asphondylia eupatorii Felt, snakeroot bud gall, Mrs E. P. Gardner, Canandaigua lake. Through S. H. Burnham

Contarinia virginianiae Felt, chokecherry midge, galls on chokecherry, August 8, J. C. Chapais, Quebec, Canada

Monarthropalpus buxi Lab., box leaf midge, larvae on Box, April 2, L. R. Simons, Mineola. Same, galls and adults on Box, April 10, H. D. Smith, Sacramento, Cal. Same, May 6, E. O. Essig, Berkeley, Cal.

Parallelodiplosis cattleyae Moll., orchid root gall, galls on orchid roots, November 12, D. K. MacMillan, Chicago, Ill.

Itonida foliora Rssl. & Hkr., oak leaf fold gall on oak, July 20, Mrs E. P. Gardner, Canandaigua

Cecidomyia bedeguar Walsh, mossy thorn gall, on Crataegus, June 14, Frank Dobbin, Shushan

C. pellex O. S., on ash, June 14, Mrs E. P. Gardner, Canandaigua

C. viticola O. S., conical grape gall on grape, October 5, Mrs E. P. Gardner, Canandaigua

Eristalis tenax Linn., drone fly, rat-tailed larva, September 24, Mrs B. L. Hand, Elizabethtown

Rhagoletis pomonella Walsh, apple maggot, work in apple, September 7, George Miller, Rhinebeck. Through F. H. Lacy. Same, October 6, A. M. Lane, Schenectady

Pollenia rudis Fabr., cluster fly, adults, September 18, Mrs D. O. Wickham, Champlain

Lepidoptera

Papilio glaucus-turnus Linn., black swallow-tail, caterpillar, September 17, Miss Nettie E. Squire, Canton

Callosamia promethea Dru., Promethea moth, adult, July 7, Emma E. Scott, Albany. Same, July 9, Margaret Fahrenkopf, Albany. Same, larva on lilac, August 23, Mrs E. Russel Mead, Albany

Tropea luna Linn., luna moth, cocoon, April 12, Mrs Horace L. Greene, Fort Plain. Same, adult, June 30, Thomas Albright, West Coxsackie

Telea polyphemus Cram., American silk worm moth, June 17, H. T. Wakely, Corinth. Same, adult, September 2, Edward Adriance, Albany

Automeris io Fabr., io moth, larva, August 30, L. A. G. Gale, Albany. Same, larvae, September 3, Miss Laura F. Eldredge, Canajoharie

Basilona imperialis Dru., Imperial moth, caterpillar, September 20, Samuel Hessberg, Albany

Estigmene acraea Dru., Acraea moth, June 4, G. G. Atwood, Jericho. Through State Department of Agriculture. Same, June 23, Miss Eliza S. Blunt, New Russia

Halisidota, caryae Harr., caterpillar, September 20, C. A. Hartnagel, Albany

Agrotis ypsilon Rot., greasy cutworm, larvae on gladioli, June 6, Joseph King, Nassau

Peridroma saucia Hübn., variegated cutworm, caterpillar, February 24, G. G. Atwood, Cayuga county. Through State Department of Agriculture

Noctua clandestina Harr., moths, September 16, Mrs Frances P. Gavit, Stony Creek

Euthisanotia grata Fabr., beautiful wood nymph, adult, July 16, R. F. Avery, Kinderhook

Erebus odora Linn., adult, June 23, Emma E. Scott, Albany. First taken in the State and brought to the Museum in twenty years

Datana major Grote & Rob., larvae on Rhododendron, July 19, P. F. Keil, Westbury

D. integerrima Grote & Rob., caterpillars, August 6, L. R. Simons, Mineola

Hemerocampa leucostigma Sm. & Abb., white-marked tussock moth, eggs on horse-chestnut, March 24, E. H. Cooper, Troy

Euproctis chrysorrhoea Linn., brown-tail moth, nests, February 11, L. C. Griffith, Amagansett. Same, web on Massachusetts stock, May 11. Through State Department of Agriculture

Erannis tiliaria Harr., imago, October 22, J. R. Gillett, Kingston

Ennomos magnarius Guen., notch-wing, adults, November 11, Delbert Bishop, Millerton. Through F. H. Lacy

Sibine stimulea Clem., saddle-back caterpillar, larvae on golden glow, September 5, Mrs J. C. Wheaton, Yonkers

Zeuzera pyrina Linn., leopard moth, larva on Gordonia altamaha, September 9, Leonard Barron, Garden City

Phlyctaenia ferrugalis Hübn., greenhouse leaf-tyer, moth and work on Chrysanthemum, October 22, C. H. Zimmer, Lynbrook. Same, adult and larva, January 23, John Dunbar, Rochester

Plodia interpunctella Hübn., Indian meal moth, adult, July 17, Miss Ruth M. Case, Peconic. Same, larvae in beans, September 29, W. E. Waterbury, East Schodack

Oxyptilus periscelidactylus Fitch, gartered plume moth, caterpillar on grape, May 28, L. R. Simons, Mineola

Evetria buoliana Schiff., European pine twig moth, work, April, Buffalo. Through State Department of Agriculture. Same, larvae, June 1, S. G. Harris, Tarrytown. Same, pupae on Mugho pine, June 15, A. R. Miller, South Jamaica. Through State Department of Agriculture. Same, pupa on pine, June 22.

J. J. de Vyver, Flushing. Same, on Mugho pine, June 29, Buffalo. Through State Department of Agriculture

Archips cerasivorana Fitch, ugly nest cherry worm, in web on Lombardy poplar, June 18, C. B. Cutler, East Greenbush

Yponomeuta malinella Zell., ermine moth, young caterpillars, June 4, G. G. Atwood, Geneva. Through State Department of Agriculture

Ectoedemia populella Busck, ridged leaf stem gall; galls and larva on cottonwood August 23, J. C. Howard, Ogdensburg

Coptodisca splendoriferella Clem., resplendent shield bearer, work on wild cherry, October 19, F. J. Seaver, New York City

Incurvaria acerifoliella Fitch, maple leaf cutter, work on maple, September 10, H. L. Bailey, Brad'ord, Vt.

Platyptera

Corydalis cornuta Linn., horned Corydalis, August 5, W. A. Melius, Ghent

Odonata

Aeschna clepsydra Say, dragonfly, adult, June 29, Raymond Sullivan, Albany

Hemiptera

Tibicen septemdecim Linn., seventeen year Cicada, adult, June 18, J. H. Livingston, Tivoli

Ormenis pruinosa Say, lightening leaf hopper, nymphs on grape, etc., July 21, R. H. Tedford, Albany

Aphrophora quadrinotata Say, four-spotted spittle insect, adults and larvae on Helianthus, July 7, Alfred Vander Veer, Big Moose lake

Philaenus lineatus Linn., lined spittle insect on grass, June 25, D. V. Haggerty, Poughkeepsie

Oncometopia undata Fabr., adults, June 30, Doubleday, Page & Company, Garden City

Phylloxera caryaecaulis Fitch, hickory stem gall, June 14, Frank Dobbin, Shushan. Same on hickory, Mrs E. P. Gardner, Canandaigua. Same, June 26, Board of Park Commissioners, Rochester. Through John Dunbar

P. foveola Perg., on hickory, June 14, Mrs E. P. Gardner, Canandaigua

Chermes abietis Linn., spruce cone gall on spruce, April 15, Mrs E. P. Gardner, Canandaigua

C. pinifoliae Fitch, pine leaf Chermes, eggs on white pine, January 19, Arthur Cowee, Berlin. Same, young on pine, July 30, P. W. Harter, Utica

C. strobilobius Kalt., woolly larch aphis, adults, eggs and young, June 15, Benjamin Hammond, Beacon. Same, adults and young on larch, July 29, P. W. Harter, Utica

Pemphigus populicaulis Fitch, galls on poplar, July 16, L. R. Simons, Mineola

P. ulmifusus Walsh, slippery elm gall on elm, October 5, Mrs E. P. Gardner, Canandaigua

Colopha ulmicola Fitch, cockscomb elm gall, on elm, June 30, Martha J. Naramere, Ossining

Schizoneura lanigera Hausm., woolly apple aphis, June 19, Benjamin Hammond, Beacon

Aphis mali Fabr., green aphis on apple, April 21, J. S. Langford, Shushan

A. sorbi Kalt., rosy aphis on young orchard trees, June 3, G. A. Lintner, Summit, N. J.

Myzus ribis Linn., currant aphis on currant, May 22, Harold Wilson, jr, Clermont. Same, young, June 18, Mrs Charles S. Phelps, Canton

M. cerasi Fabr., black cherry aphis, adults on cherry, June 18, W. C. Johnston, Cooperstown

Gossyparia spuria Mod., elm bark louse, adults, June 9, F. J. Seaver, New York City. Same, adults on elm, June 12, T. W. Baldwin, Nyack.

Eriococcus azaleae Comst., adults on huckleberry, May 22, C. P. Phelps, Canton

Phenacoccus acericola King, false maple scale, male cocoons, April 30, J. J. de Vyver, Flushing. Same, adults on sugar maple, August 21, A. O. Smith, Mount Vernon

Pseudococcus citri Risso, mealy bug, August 5, Mrs E. Russel Mead, Albany

Coccus hesperidum Linn., soft or brown scale on fern, January 25, Mrs A. C. Aammond, Schenectady

Eulecanium fletcheri Ckll., on Juniper, June 14, Mrs E. P. Gardner, Canandaigua. Same, June 15, Antoine La Clair, Valcour

Eulecanium nigrofasciatum Perg., Terrapin scale on red maple, November 12, F. J. Whaley, Albany

Chionaspis pinifoliae Fitch, pine leaf scale on pine, October 17, J. J. de Vyver, Flushing. Same, eggs on pine, November 5, J. A. Sweigert, Plattsburg. Same, March 17, H. C. Shears, Hyde Park. Same, on spruce, September 18, Richard Harrar, New York City

Aulacaspis rosae Sandb., rose scale, eggs on rose, March 27, Benjamin Hammond, Fishkill

Leucaspis japonica Ckll., on Norway maple and Privet, December 5, Frost & Bartlett Company, Stamford, Conn.

Aspidiotus abietis Schr., on hemlock, September 30, F. J. Seaver, New York City

A. perniciosus Comst., San José scale on birch infested by parasites, October 26, F. J. Whaley, Schenectady

Orthoptera

Blatta orientalis Linn., cockroach, adult, September 1, C. E. Eldredge, Leon

Thysanura

Thermobia furnorum Prov., silver-fish, bristle-tail or fish moth, adult, March 26, F. J. Stubing, Mount Vernon

Mallophaga

Docophorus haleti Osb., on Eagle, June 2, W. G. Van Name, Saranac Lake. Through State Conservation Commission

EXCHANGE

The following species were received from Dr Nathan Banks, East Falls Church, Va.

Psychoda nigra *Bks.*
P. superba *Bks.*
P. apicalis *Bks.*
P. albitarsis *Bks.*
Clitellaria subulata *Lw.*
Apatolestes comastes *Will.*]
Rhachicerus obscuripennis *Lw.*
Dialysis rufithorax *Say*
Chrysopila rotundipennis *Lw.*
C. apicalis *V. d W.*
C. basalis *Say*
Exoprosopa emarginata Macq.
Systropus macer *Lw.*
Geron senilis *Fabr.*
Leptogaster atridorsalis *Back*
L. brevicornis *Lw.*
Holopogon philadelphicus *Schin.*
Cerotania macrocera *Say*
Mallophora clausicella *Macq.*
Asilus autumnalis *Bks.*
Baccha tarchetius *Walk.*
Myrmecomyia myrmecomoides *Lw.*
Euxesta scoriacea *Lw.*
Lipochaeta slossonae *Coq.*

The following Sarcophagidae were received from Mr R. R. Parker, assistant entomologist, Bozeman, Mont.

Wohlfahrtia opaca *Coq.*
Boettcheria latisterna *R. Pkr.*
B. bisetosa *R. Prk.*
B. cimbicis *Towns.*
Sarcophaga sinuata *Meigen*
S. cooleyi *R. Prk.*
S. aldrichi *Mans.*
S. haemorrhoidalis *Meigen*
S. falculata *Pandellé*
S. dalmatina *Schiner*
S. sarraceniae *Riley*
S. kellyi *Aldrich*
S. harpax *Pandellé*
S. bullata *Mans.*
S. scoparia *Pandellé*
S. helicis *Towns.*
S. assidua *Walk.*
Ravinia communis *R. Pkr.*
R. peniculata *R. Pkr.*
R. quadrisetosa *Coq.*

ADDENDA

Sarcophaga bullata R. Parker

The original data given in Museum Bulletin 165, page 80, and the illustrations on plate 7, relate to the above-named species, a recently characterized form, and not to Sarcophaga georgina Wied.

Figure 4, plate 7, of this bulletin illustrates the male genitalia of Phormia regina Meig. and not that of a species of Sarcophaga.

APPENDIX

A STUDY OF GALL MIDGES IV

FAMILY ITONIDIDAE

TRIBE — ASPHONDYLIARIAE

The tribe comprises mostly large, heavy-bodied insects easily recognized by the long, cylindric, sessile antennal segments and the simple claws. Members of this group breed largely in the flower buds or fruits of various plants. The four known American genera display a considerable variety in food preferences. Asphon-

Fig. 1 Asphondylia monacha. Lateral view of female, enlarged (original)

dylia is represented by a rather large series of species, while the somewhat nearly related Schizomyia possesses very similar habits. The highly specialized Cincticornia is largely, if not entirely restricted to various leaf galls on oak, Quercus.

Key to North American genera

a Ovipositor protractile, aciculate or nearly so, the terminal clasp segment of the male usually uni- or bidentate
- *b* Palpi quadriarticulate, the flagellate antennal segments with long, whorled hairs and two strongly sinuous and anastomosing circumfili, especially in the male
  - *c* Ovipositor aciculate with lamellae apically; larval breastbone bidentate — Schizomyia Kieff.
- *bb* Palpi bi- or triarticulate, rarely uniarticulate
  - *c* Circumfili in the female consisting of two comparatively simple bands
    - *d* Terminal clasp segment of the male uni- or bidentate, not pectinate
      - *e* Subcostal cell normal, not opaque, the ovipositor with a lobed pouch proximally, not vesiculate — Asphondylia H. Lw.

aa Ovipositor exserted, apically with lobes or triangular plates; terminal clasp segments of the male usually serrate apically
- *b* Palpi quadriarticulate
  - *c* Terminal clasp segment of the male apical; third and fourth antennal segments fused, the circumfili usually with many fine reticulations in the male, the pulvilli usually shorter than the claws — Cincticornia Felt
- *bb* Palpi triarticulate
  - *c* Terminal clasp segment of the male serrate apically
    - *d* Circumfili of male coarse, very irregular, there being four or five transverse fili to a segment, the plates of the ovipositor triangular — Feltomyia Kieff.[1]

SCHIZOMYIA Kieff.

Kiefferia Mik

1889 **Kieffer, J. J.** Ent. Nachr., 15:183, 184
1892 ———— Wien Ent. Zeit., 11:218
1892 **Rubsaamen, E. H.** Berl. Ent. Zeitschr., 37:328, 381
1895 **Kieffer, J. J.** Wien Ent. Zeit., 14:11
1895 **Mik, Josef.** Wien Ent. Zeit., 14:95, 96 (Kiefferia)
1895 **Rubsaamen, E. H.** Ent. Nachr., 21:4
1897 **Kieffer, J. J.** Syn. Cecid. de Eur. & Alg., p. 18
1900 ———— Soc. Ent. Fr. Ann., 49:449, pl. 16, fig. 6; pl. 19, fig. 7; pl. 20, fig. 1; pl. 32, fig. 1, 2, 10
1908 **Felt, E. P.** N. Y. State Mus. Bul. 124:378
1911 ———— N. Y. Ent. Soc. Jour., 19:48
1913 **Kieffer, J. J.** Gen. Insect., fasc. 152, p. 88
1915 **Felt, E. P.** U. S. Nat'l. Mus. Proc. 48:197

Antennae consisting of 14 cylindric, sessile or subsessile segments, those of the male slightly shortened distally and each with remarkably stout, elevated, strongly convolute circumfili. Palpi with 4 segments. The basal clasp segment of the male genitalia projects well beyond the insertion of the terminal clasp segment, which latter bears

[1] Judging from larval characters this genus is closely related to, and may possibly be a synonym of Uleella Rubs., a genus founded upon a larva.

apically a more or less distinct chitinous tooth. Female with the distal antennal segments greatly shortened as in Asphondylia, the

Fig. 2 Schizomyia rubi. Lateral view of body showing extended ovipositor, enlarged (original)

circumfili nearly the same as in this older genus. Ovipositor with a distinct fleshy basal portion, tapering distally and bearing the characteristic though somewhat modified aciculate organ of Asphondylia. The dorsal pouch absent. The seventh abdominal segment with a more or less strongly chitinized ventral sclerite characteristic of this genus. Type S. galiorum Kieff.

Several European species have been reared from enlarged flower buds of various plants. The West Indian S. ipomoeae Felt was obtained in abundance from flower buds of Ipomoea

Key to species

a Abdomen dark brown
  b Wings rather large, narrow
    c Scutellum reddish, fifth antennal segment with a length four times its diameter, the fourth palpal segment one-half longer than the third, female; taken on viburnum blossoms....viburni Felt C. 1212
    cc Scutellum fuscous yellowish, fifth antennal segment with a length six times its diameter, the fourth palpal segment twice the length of the third, female.............caryaecola Felt C. a1786a
aa Abdomen reddish brown
  b Antennae unicolorous
    c Wings small, narrow......................altifila Felt, C. 177
    cc Wings small, broad..........................rubi Felt, C. 685
    ccc Wings large, rather broad. Reared from Amsinckia galls......... macrofila Felt, C. 855, 1001
  bb Antennal segments annulate with yellowish basally. Reared from Ipomoea buds.......................ipomoeae Felt, C. a2022
aaa Abdomen yellowish or light brown
  b Wings large, tarsi unicolorous or nearly so
    c Fifth antennal segment with a length six times its diameter, the fourth palpal segment with a length one-fourth greater than the third, female; reared from apical leaf bud gall on grape.................. coryloides Walsh & Riley, C. 874
    cc Fifth antennal segment with a length five times its diameter, fourth palpal segment with a length three-fourths greater than the third, male; reared from hard, nutlike, polythalamous gall on grape....................pomum Walsh & Riley, a1434b

bb Wings small, broad

c Posterior tarsi rather broadly yellow banded; fifth antennal segment with a length six times its diameter, the fourth palpal segment one-fourth longer than the third, female; reared from bud galls on Rivina humilis.................... rivinae Felt, C. 943

cc Posterior tarsi dark brown and broadly whitebanded; fifth antennal segment with a length five times its diameter; fourth palpal segment one-half longer than the third; female.... speciosa Felt, C. 1507

ccc Posterior tarsi black; fifth antennal segment with a length four or five times its diameter, the fourth palpal segment one and one-half and one and three-fourths the length of the third in the male and female respectively; reared from oval or fusiform tendril or petiole galls on Vitis bicolor........ petiolicola Felt, C. a1784

Schizomyia viburni Felt

1908 **Felt, E. P.** N. Y. State Mus. Bul. 124:378

This female was taken June 20, 1907 at Old Forge, N. Y., apparently as she was about to oviposit in Viburnum blossoms. It is possible that later rearings may prove this to be the other sex of S. altifila.

Female. Length 1.5 mm. Antennae nearly as long as the body, sparsely haired, dark brown; 14 segments, the third with a length fully four times its diameter. Palpi; the first segment short, stout, subquadrate, the second more slender, about one-half longer, the third a little longer and more slender than the second, the fourth one-half longer than the third. Mesonotum dark brown, the submedian lines sparsely clothed with fine hairs. Scutellum yellowish brown with numerous light setae apically, postscutellum a little darker. Abdomen dark brown, the segments rather thickly margined posteriorly with coarse setae; venter lighter. Wings hyaline, costa light brown; halteres pale yellowish. Coxae and base of femora fuscous yellowish, distal portion of femora, tibiae and tarsi a nearly uniform dark brown; claws long, slender, strongly curved, the pulvilli shorter than the claws. Ovipositor probably nearly as long as the body. Type Cecid. 1212.

Schizomyia caryaecola Felt

1908 **Felt, E. P.** N. Y. State Mus. Bul. 124:378

The one female was reared June 1, 1908 from a jar containing a long, conic leaf gall on Bitternut or swamp hickory, Carya cordiformis and undoubtedly produced by Caryomyia caryaecola O. S. It is probable that the occurrence of the midge in this jar was accidental.

Female. Length 2 mm. Antennae nearly as long as the body, thickly short haired, reddish brown; 14 segments, the fifth cylindric, with a length about five times its diameter. Palpi; the first segment short, stout, irregularly quadrate, the second with a length about three times its diameter, the third one-fourth longer than the second, more slender, the fourth three-fourths longer than the third; face yellowish. Mesonotum light brown, the submedian lines thickly clothed with fulvous hairs. Scutellum fuscous yellowish, postscutellum a little darker. Abdomen dark reddish brown, the segments rather thickly margined posteriorly with fulvous setae; venter thickly clothed with setae, the apical segments darker. Wings hyaline, costa light brown; halteres yellowish, fuscous subapically. Coxae, femora and tibiae mostly dark brown, the posterior legs with the basal two-thirds of the femora light fuscous yellowish and with the first tarsal segment, the base and the distal half of the second and the third mostly fuscous yellowish; claws long, slender, evenly curved, the pulvilli about one-third the length of the claws. Ovipositor about as long as the body. Type Cecid. a1786a.

Schizomyia altifila Felt

1907 **Felt, E. P.** N. Y. State Mus. Bul. 110:119 (separate, p. 23 [Asphondylia])

1908 ———— N. Y. State Mus. Bul. 124:378

This species was taken at Lake Clear, N. Y., June 7, 1906, sweeping blueberry, Vaccinium bushes in the vicinity of woods.

Male. Length 1.5 mm. Antennae as long as the body, thickly fine white haired, dark brown; 14 segments, the third with a length four times its diameter. Palpi; the first segment short, subquadrate, the second as long as the first, much broader, the third twice the length of the second, more slender, the fourth one-half longer than the third. Mesonotum very dark brown, submedian lines paler with sparse setae. Scutellum and postscutellum reddish brown. Abdomen dark reddish brown, thickly yellow haired laterally. Wings hyaline, costa dark reddish brown. Halteres reddish transparent basally, yellowish white apically. Legs dark straw color, the tarsi slightly darker; claws stout, uniformly curved. Genitalia; dorsal plate broad, the sides parallel, broadly and triangularly emarginate; ventral plate narrow, broadly and roundly emarginate. Type Cecid. 177.

Fig. 3 Schizomyia altifila. Sixth antennal segment of male, enlarged (original)

Schizomyia rubi Felt

1907 **Felt, E. P.** N. Y. State Mus. Bul. 110:119–20 (separate, p. 23 [Asphondylia])

1908 ———— N. Y. State Mus. Bul. 124:379

This species was swept from high blackberry at Karner, N. Y., July 24, 1906.

Female. Length 1.5 mm. Antennae extending to the fourth abdominal segment, sparsely haired, dark brown; 14 segments, the third with a length six times its diameter. Palpi; the first segment irregularly subquadrate, the second short, swollen basally, the third a little longer, tapering distally, subquadrate, the fourth nearly twice the length of the preceding, more slender. Mesonotum yellowish brown, submedian lines ornamented with long, yellowish setae. Scutellum reddish brown with sparse apical setae, postscutellum dark brown. Abdomen dark reddish with irregular dark brown markings on the dorsum of the second, third and seventh abdominal segments. Ovipositor yellowish orange. Wings subhyaline, unspotted, costa thickly clothed with dark brown hairs; halteres yellowish basally, the base of club fuscous, tip whitish transparent. Coxae mostly fuscous, anterior and mid femora mostly black, narrowly ringed with pale yellowish, posterior femora with basal half pale yellowish, distal half fuscous; tibiae black with articulations yellowish or tinged with carmine, fore and mid tarsi black,

a *b*

Fig. 4 Schizomyia rubi. *a*, lateral aspect of the distal portion of the last tarsal segment and claw; *b*, ventral plate of female, enlarged (original)

the segments narrowly ringed basally with yellowish or yellowish white, posterior tarsi mostly yellowish with sparse, irregular, fuscous markings on the middle of the second segment, distal segments dark brown or fuscous; claws long, rather stout, evenly curved. Ovipositor very slender (fig. 2), nearly twice the length of the body. Type Cecid. 685.

Schizomyia macrofila Felt

1907 **Felt, E. P.** New Species of Cecidomyiidae II, p. 16 (Asphondylia)
1908 ———— N. Y. State Mus. Bul. 124:297, 379

This species was reared May 4, 1887 from galls on Amsinckia lycopsoides collected by Mr A. Koebele April 8th at Los Angeles and Alameda, Cal. The gall was also taken in California and adults reared by the late D. W. Coquillett.

Male. Length 2 mm. Antennae nearly as long as the body, sparsely haired, light brown; 14 segments, the third with a length five times its diameter. Palpi; the first segment narrowly oval, the second one-fourth longer, more slender, the third one-half longer than the second, broader, the fourth one-half longer than the third, slender. Face reddish yellow. Mesonotum dark brown, the submedian lines sparsely yellow haired. Scutellum pale yellowish, sparsely setose apically, postscutellum dark brown. Abdomen thickly clothed with fine hairs, reddish brown. Genitalia fuscous yellowish. Wings hyaline, costa light brown. Halteres yellowish, reddish brown subapically. Legs reddish brown, the tarsi slightly darker; claws long, slender, evenly curved, the pulvilli shorter than the claws. Genitalia; dorsal plate short, stout, deeply and narrowly incised, the lobes obliquely truncate, the lateral angles greatly produced; ventral plate short, stout, broadly and roundly emarginate.

Fig. 5 Schizomyia macrofila. Sixth antennal segment of male, enlarged (original)

Female. Length 2 mm. Antennae shorter than the body, sparsely haired, dark brown; 14 segments, the third with a length five times its diameter. Palpi; the first segment broadly oval, the second longer, nearly as stout, the third one-half longer than the second, more slender, the fourth nearly twice the length of the third, more slender. Other characters nearly as in the male. Type Cecid. 855.

Schizomyia ipomoeae Felt

1910 **Felt, E. P.** Ent. News, 21:160–61

This interesting species, described elsewhere, was reared in large numbers by William H. Patterson of St Vincent, B. W. I., from flower buds of Ipomoea. It is most easily distinguished from American forms by its small size, the reddish brown abdomen and in particular by the varicolored antennae, the segments basally being a more or less distinct yellowish.

Larva. Length 3 mm, rather stout, yellowish or yellowish orange. Head small; antennae rather long, stout; breastbone well chitinized, bidentate, tapering and somewhat obsolescent. Skin coarsely shagreened. Posterior extremity broadly rounded.

Schizomyia coryloides Walsh & Riley

Grape filbert gall

1864 **Walsh, B. D.** Ent. Soc. Phil. Proc., 3:588–91 (Cecidomyia)
1867 ———— Ent. Soc. Phil. Proc., 6:224 (Cecidomyia)
1868 ———— **& Riley, C. V.** Amer. Ent., 1:106–7 (Cecidomyia vitis-coryloides)
1869 **Packard, A. S.** Guide Study Ins., p. 376–77 (Cecidomyia vitis-coryloides)
1873 **Riley, C. V.** Ins. Mo., 5th Rep't, p. 116–17 (Cecidomyia vitis-coryloides)
1906 **Felt, E. P.** Ins. Affect. Prk. & Wdld. Trees, N. Y. State Mus. Mem. 8, 2:745 (Cecidomyia)
1908 ———— N. Y. State Mus. Bul. 124:379
1909 **Burrill, A. C.** Wis. Nat. Hist. Soc. Bul. 7:130 (Cecidomyia)
1910 **Stebbins, F. A.** Springf. Mus. Nat. Hist. Bul. 2:44

The gall of this species occurs on grape. Apparently the same gall is found on wild frost grape in Illinois and was described and figured by Messrs Walsh and Riley in 1868. They state that the gall develops from a common center at a point where a bud would ordinarily occur. Occasionally a normal leaf grows from some portion of the mass and sometimes bears two galls at the juncture of the stem with the leaf. Each gall is one celled, the cavity being

Fig. 6 Schizomyia coryloides. *a*, fifth and sixth antennal segments of male, the reverse shown in outline; *b*, palpus, enlarged (original)

about one-fourth of an inch long, one-fourth as wide and containing a single larva. Large specimens of this gall bear a general resemblance to a bunch of filbert or hazelnuts as they grow on a bush, which led to the designation "vitis-coryloides." Galls of this species

were collected at Georgiana, Fla., by Mr William Wittfeld. They were received by the division of entomology June 25, 1883, adults issuing in March 1884.

Male. Length 2 mm. Antennae shorter than the body, thickly haired, light brown; 14 segments, the third with a length about two and one-half times its diameter. Palpi; the first segment short, stout, subquadrate, the second one-half longer, slender, the third a little longer and more slender than the second, the fourth about two and one-half times the length of the third, strongly flattened. Mesonotum reddish brown, the base of the wings and the anterior lateral angles yellowish, the submedian lines rather thickly clothed with yellowish brown hairs. Scutellum light yellowish brown, postscutellum a little lighter. Abdomen mostly yellowish brown; genitalia reddish brown, the segments rather sparsely margined posteriorly with long, yellowish hair, this being most abundant on the eighth segment. Wings hyaline, costa light brown. Halteres yellowish basally, fuscous apically. Coxae and base of femora light yellowish brown, the other portion of the legs a variable reddish brown; claws long, slender, evenly curved, the pulvilli almost rudimentary. Genitalia; dorsal plate long, broad, deeply and narrowly incised, the lobes roundly tapering; ventral plate long, stout, tapering, deeply and roundly emarginate, the lobes short, obtuse.

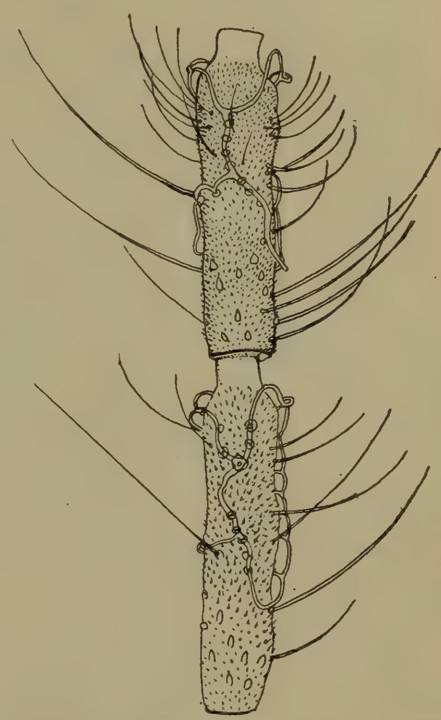


Fig. 7 Schizomyia coryloides. Fifth and sixth antennal segments of female, enlarged (original)

Female. Length 2.5 mm. Antennae extending to the fourth abdominal segment, thickly fine haired, light reddish brown, the basal segments yellowish; 14 segments, the third with a length about five times its diameter. Palpi; the first segment stout, swollen, narrowly oval, the second one-half longer, more slender, the third a little longer and more slender than the second and the fourth about as long as the third, strongly flattened; face yellowish. Ovipositor yellowish orange, about as long as the body. Otherwise nearly as in the male. Cecid. 874.

Schizomyia pomum Walsh & Riley

Grape apple gall

1869 **Walsh, B. D., & Riley, C. V.** Am. Ent., 1:106 (Cecidomyia vitis-pomum)

1869 **Packard, A. S.** Guide for the Study of Ins., p. 378 (Cecidomyia)

1873 **Riley, C. V.** Nox. & Other Ins. Mo., 5th Rep't, p. 114–16 (Cecidomyia)
1874 **Glover, Townend.** MS. Notes from My Journ. Dipt., pl. 9, fig. 17 (Cecidomyia)
1883–1889 **Saunders, William.** Ins. Inj. Fruits, p. 295–96 (Cecidomyia)
1892 **Beutenmueller, William.** Am. Mus. Nat. Hist. Bul. 4:272 (Cecidomyia)
1899 **Smith, J. B.** List Ins. N. J., p. 621 (Cecidomyia)
1904 **Beutenmueller, William.** Am. Mus. Nat. Hist. Guide Leaflet 16, p. 32 (Cecidomyia)
1908 **Felt, E. P.** N. Y. State Mus. Bul. 124:379
1909 ——— Ent. Soc. Ont., 39th Rep't, p. 45
1909 **Burrill, A. C.** Wis. Nat. Hist. Soc. Bul. 7:130 (Cecidomyia vitis-pomum)
1910 **Stebbins, F. A.** Springf. Mus. Nat. Hist. Bul. 2:44

This species was first brought to notice by Messrs Walsh and Riley, who characterized the gall as an applelike growth on grapevines (Vitis cordifolia). This gall is evidently widely distributed. It has been recorded as common in New Jersey, in the vicinity of New York City, in Virginia and from Wisconsin. It is comparatively easy to find a few of the characteristic galls made by this insect in most localities in New York State and in some places it is almost abundant. Numerous large-sized galls were taken at Westfield, N. Y., on the summer grape (Vitis bicolor) while scattered, smaller specimens were found on the northern fox grape (Vitis labrusca) at Hamburg, the larvae from both appearing identical.

The insect is a difficult one to rear, and it was only after repeated trials that we succeeded, May 28, 1908, in obtaining an adult from a number of galls collected the preceding season. The galls are evidently modified buds and, with the advance of the season, ripen and drop probably with the falling foliage. The insects remain in their retreats over winter and by spring the hard, woody tissues of the gall seem to have mostly disappeared and the flies have little difficulty in emerging from their shelters. Larvae may possibly survive a second winter as living examples were found in February 1907 in galls that were probably collected in the fall of 1906. There is presumably but one generation annually. The structure of the gall with its two layers of cells placed end to end and separated by a thin septum, suggests that each is made by a single female depositing her eggs in a symmetrical manner around a young shoot. Polymecus picipes Ashm. and Polygnotus sp. were reared from this gall.

Gall. The gall is sometimes quite flattened or depressed though more often subspherical or flattened at the base and somewhat pointed at the tip. The young gall is green and covered with a fine

pubescence. It becomes a rosy red in part with the advance of the season. It is succulent when young and is credited with possessing a pleasant subacid flavor. The fully developed gall usually has 8 or 9 longitudinal ribs somewhat like those of a muskmelon, though smoother. A section reveals an outer fleshy wall and within a hard, woody interior containing a number of longitudinal cells arranged in two tiers, the upper tier of cells being frequently twice as long and more distinctly separated by a hard fiber than the lower.

Larva. Length 3 mm, rather stout, pale orange and recognizable by the heavily chitinized, armed, irregular area at the posterior extremity (figure 8). The head is small, with a diameter about one-fifth that of the body; the antennae short, stout, subcylindric;

Fig. 8 Schizomyia pomum. Posterior extremity of larva, enlarged (original)

breastbone short, stout, bidentate; the segmentation is rather distinct and the surface of the skin is minutely papillate. The posterior extremity is broadly rounded and with an irregular, heavily chitinized area, the latter bearing a pair of submedian, irregular, chitinous processes. A broadly triangular, chitinous ventral plate, rounded posteriorly, is observable in some specimens.

Male. Length 1.75 mm. Antennae nearly as long as the body, sparsely haired, light brown; 14 segments, the fifth cylindric, with a length about five times its diameter. Palpi; the first segment short, stout, irregularly subquadrate, the second narrowly oval, with a length about two and one-half times its width, the third fully twice the length of the second, slender, the fourth three-fourths longer than the third, slender. Mesonotum dark brown, the sparsely haired submedian lines and lateral and anterior margins fuscous yellowish. Scutellum reddish yellow, postscutellum yellowish. Abdomen sparsely haired, mostly fuscous yellowish, the basal segment and genitalia fuscous. Wings hyaline, costa dark brown. Halteres yellowish basally, fuscous apically; coxae and femora

basally fuscous yellowish, the distal portion of femora, tibiae and tarsi variably tinged with reddish, the latter probably abnormal, as the specimen adhered to the glass side of the breeding cage. Claws long, slender, evenly curved, the pulvilli about one-third the length of the claws. Genitalia; dorsal plate rather long, broad, deeply and triangularly incised, the lobes diverging, obliquely rounded; ventral plate broad at base, deeply and narrowly incised. Cecid. a1434b.

Schizomyia rivinae Felt

1908 **Felt, E. P.** N. Y. State Mus. Bul. 124:379

The female described below was reared from a bud gall on bloodberry, Rivina humilis, June 22, 1882 from specimens collected by William Wittfeld, Georgiana, Fla.

Gall. Globular, pubescent, green, the tips whitish and rose colored (Pergande).

Larva. Reddish orange, paler toward the head and with yellowish white spottings laterally; breastbone slender, brown; spiracles small, black; on the penultimate segment posteriorly are two tubelike cylindrical projections in addition to the spiracles; the last segment short, round, and without appendages; the body covered with pointed granules, those along the sides directed backward (Pergande).

Female. Length 1.5 mm. Antennae about as long as the body, sparsely clothed with fine hairs, light brown; 14 segments, the third with a length fully four times its diameter. Palpi; the first segment short, stout, irregularly subquadrate, the second fully twice the length of the first, the third one-fourth longer than the second, more slender, the fourth one-half longer than the third, more slender. Mesonotum light brown, the submedian lines sparsely haired. Scutellum yellowish brown, postscutellum slightly darker. Abdomen light brown, the ovipositor pale yellowish. Wings hyaline, costa dark brown. Halteres pale yellowish, slightly fuscous subapically. Coxae mostly pale yellowish, a narrow band near the middle on the anterior and mid femora, the basal two-thirds of the posterior femora, a narrow apical band on the tibiae and broad apical bands on the tarsal segments, pale yellowish, the other portions of the legs light brown; claws long, slender, strongly curved at the base, the pulvilli rudimentary. Ovipositor about as long as the abdomen. Type Cecid. 943.

Schizomyia speciosa Felt

1914 **Felt, E. P.** Psyche 20:112

This striking midge, collected by Mrs A. T. Slosson at Franconia, N.H., may be separated from S. rivinae Felt by its somewhat larger size, the darker color of the abdomen, the more distinctly and broadly white-banded posterior tarsi and the relatively longer antennal segments.

Schizomyia petiolicola Felt

1908 **Felt, E. P.** N. Y. State Mus. Bul. 124:379
1909 ———— Ent. Soc. Ont., 39th Rep't, p. 45

This species was reared April 24, 1908 from oval or fusiform petiole or tendril galls occurring on the summer grape (Vitis bicolor). The galls were taken at Westfield, N. Y., in October 1907 and were locally rather abundant. Polygnotus sp. was reared from this gall.

Gall. The gall produced by this species has a length of about 2.5 cm and a diameter of .7 cm. The color is usually a light brown, and in the case of those occurring on the petioles at least, there is frequently a rather characteristic striation, due to the rupturing of the outer bark and the light brown color of the recently exposed tissues. Occasionally two galls may occur on the same petiole. The walls are rather thin, hard, and the oval cavity is occupied by brown or black honeycombed, spongy tissue. Four to five larvae may occur in a gall. This gall presents a close resemblance to a smaller, very similar oval or fusiform petiole or tendril gall taken at Hamburg on the northern fox grape (Vitis labrusca). Possibly the two are made by the same insect and the difference in appearance is due to a variation in the habit of growth of the two plants.

Larva. Length 4 mm, rather long, slender, yellowish white, the segmentation not very apparent, the skin finely shagreened. Head small, with a width less than one-fourth that of the body and tapering to a narrowly rounded apex. Antennae rather large, the single segment being stout, with a leng about three times its diameter. Breastbone long, slender, distinct, tridentate, the median tooth about one-half the length of the lateral triangular teeth. Posterior extremity broadly rounded, with a few rather short, stout setae; anus slitlike.

The association of this larva with the above-named adult is provisional.

Male. Length 1.5 mm. Antennae a little longer than the body, thickly haired, dark brown, the basal segments yellowish, 14 segments; the fifth with a length about five times its diameter. Palpi; the first segment short, stout, somewhat expanded distally; the second rather long, broad, narrowly oval; third one-half longer and more slender than the second; fourth one-half longer and much more slender than the

Fig. 9 Schizomyia petiolicola. Terminal antennal segment of male, enlarged (original)

third; face yellowish. Mesonotum reddish brown; submedian lines thickly haired; scutellum reddish orange; postscutellum dark brown; abdomen fuscous yellowish, sparsely haired; genitalia fuscous; wings hyaline; costa light brown; halteres yellowish basally, fuscous apically; coxae and base of femora yellowish, distal portion of femora and tibiae dark brown; tarsi nearly black. Claws long, slender, strongly curved, the pulvilli a little shorter than the claws. Genitalia; dorsal plate long, broad, deeply and triangularly incised, the lobes well separated, subtriangular; ventral plate long, slender, deeply and broadly incised, the lobes long, slender.

Female. Length 1.5 mm. Antennae a little shorter than the body, sparsely haired, dark brown, the basal segment yellowish; 14 segments, the fifth with a length five times its diameter. Palpi; the first segment short, stout, subquadrate; the second one-half longer, somewhat stouter; the third about three-fourths longer than the second, more slender; the fourth nearly twice the length of the third, more slender. Mesonotum slaty brown; the submedian lines thickly haired; scutellum reddish orange; postscutellum fuscous yellowish; abdomen reddish brown, the second segment darker; all rather thickly clothed with fine hairs; costa dark brown. Ovipositor nearly as long as the body. Otherwise nearly as in the male. Type Cecid. a1784.

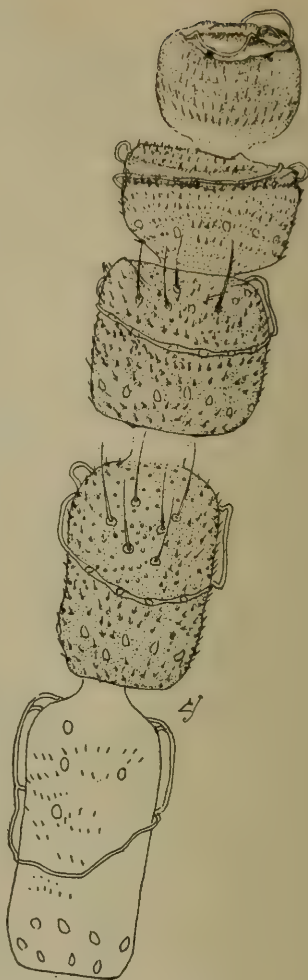


Fig. 10 *Schizomyia petiolicola*. Distal five antennal segments of female, enlarged (original)

ASPHONDYLIA Lw.

Phyllophaga Rond.

Cylindrocera Lioy

1850 **Loew, H.** Dipt. Beitr., 4:20, 21
1856 **Rondani,** Prodrom 1, p. 199 (Phyllophaga, C. fusca type)
1861 ———— Soc. Ital. Sci. Nat. Milano Atti, 2: 2, 5, 7
1862 **Osten Sacken, R.** Dipt. N. Am. Mon. 1: 176
1863 **Lioy** ———— Atti del Institut. Veneto S., 3: 503 (Cylindrocera)
1864 **Schiner, J. R.** Fauna Austriaca Dipt., 2:395
1869 **Osten Sacken, R.** Am. Ent. Soc. Trans., 2:301
1876 **Bergenstamm, J. E., & Low, Paul.** Syn. Cecidomyidarum, p. 22
1877 **Karsch, F. A. F.** Revis. d. Gallmucken, p. 15
1888 **Skuse, F. A. A.** Linn. Soc. N. S. Wales Proc., 3:37, 39, 43, 108

1892 **Kieffer, J. J.** Wien Ent. Zeit., 11:220 (A. sarothamni)
1892 **Rubsaamen, E. W.** Berl. Ent. Zeitschr., 37:367
1892 **Theobald, F. V.** Acct. Brit. Flies, p. 51, 85
1895 **Kieffer, J. J.** Wien. Ent. Zeit., 14:10
1897 ——— Syn. Cecid. de Eur. & Alg., p. 11, 19
1900 ——— Soc. Ent. Fr. Ann., 49:446, 447 (Phyllophaga) pl. 16, fig. 4; pl. 20, fig. 7; pl. 22, fig. 6; pl. 28, fig. 4; pl. 33, fig. 16, 18; pl. 34, fig.12; pl. 36, fig. 2, 11, 12, 13
1908 **Felt, E. P.** N. Y. State Mus. Bul. 124:375–76
1911 ——— N. Y. Ent. Soc. Jour., 19:47–48
1913 **Kieffer, J. J.** Gen. Insect., fasc., 152, p. 91
1915 **Felt, E. P.** U. S. Nat'l Mus. Proc., 48:197

The genus is characterized by antennae with 14 cylindric, sessile segments, those of the male only slightly reduced distally, with

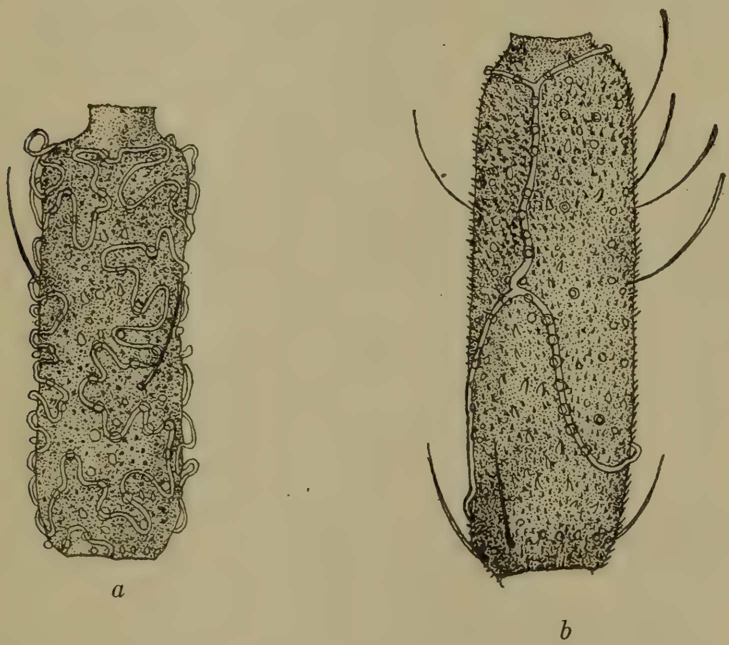


Fig. 11 Asphondylia monacha, sixth antennal segment; *a*, male; b, female, enlarged (original)

rather numerous low strongly convolute circumfili. Palpi with 1 to 3 segments. The terminal clasp segment of the male genitalia short, stout, swollen near the middle, and apically with a heavy, bidentate chitinous process. The female antennae are greatly reduced distally, the twelfth much shorter than the normal, the thirteenth with a length scarcely greater than its diameter, and the fourteenth subglobose or even reduced to a small disk, the circumfili consisting of a low band near the basal third or fourth, the branches produced on one side and fused to form a longitudinal filum which unites with a low apical circumfilum. Ovipositor with a distinct

tapering, fleshy part and a long, slender, aciculate portion. Basally there is a characteristic dorsal pouch consisting of two broadly

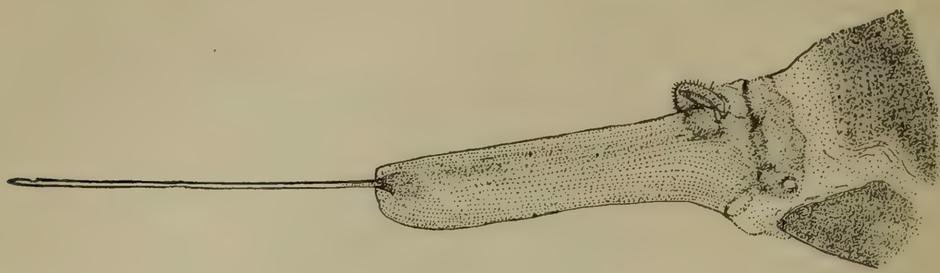


Fig. 12 Asphondylia monacha. Lateral view of ovipositor, enlarged (original)

rounded, thickly haired lobes separated mesially by a broadly rounded emargination. The type is Cecidomyia sarothamni H. Lw.

Key to species

a Palpi one-segmented
- *b* Length 1.5 mm; abdomen dark reddish brown; scutellum yellowish red.. brevicauda Felt, C. 1040
- *bb* Length 2.5 to 3 mm; abdomen with long, yellowish hairs; reared from gall on Larrea tridentata.................. auripila Felt, C. 851

aa Palpi two-segmented
- *b* Large, 3 to 4 mm long
  - *c* Abdomen dark brown or black
    - *d* Tibiae dark brown; reared from brownish, fusiform Azalea buds...................... azaleae Felt, C. a1481
      - *e* Tarsi dark brown, the posterior yellowish, terminal palp segment not tapering distally; reared from apparently unmodified flower heads of Helianthus strumosus...... helianthiflorae Felt, C. a1718
    - *dd* Anterior and mid tarsi dark brown, the posterior yellowish, terminal palp segment tapering; reared from stem gall on Eupatorium.................. eupatorii Felt, C. 1288
    - *ddd* Tibiae yellowish brown
      - *e* Tarsi dark brown; reared from swollen Opuntia fruit..... betheli Ckll., C. a1776
      - *ee* Tarsi yellowish......... fulvopedalis Felt, C. 546
  - *cc* Abdomen reddish brown; reared from unripe fruits of Sicca disticha.. siccae Felt, C. 1213

aaa Palpi three-segmented
- *b* Small, 1.5 to 2.5 mm long
  - *c* Abdomen light or reddish brown
    - *d* Scutellum pale yellowish; reared from galls on Bumelia lanuginosa...................... bumeliae Felt, C. 849
    - *dd* Scutellum reddish brown
      - *e* Basal abdominal segments yellowish; reared from bud gall on unknown shrub....... florida Felt, C. 873

ee Abdomen unicolorous; reared from flower buds of Rhus integrifolia..........integrifoliae Felt, C. 868

bb Medium sized, 3 to 4 mm long

c Tarsi plainly white-banded; reared from apical rosette gall on Euthamia lanceolata, from apparently unmodified florets of the same, and from oval galls between adherent leaves of Solidago serotina or S. canadensis..................monacha O. S. C. 761, 807, 812, 813, a1195, a1200, a1336, a1568a and y

cc Tarsi unicolorous or nearly so

d Abdomen yellowish brown

e Scutellum pale yellowish; tibiae and tarsi yellowish brown; reared from deformed berries of Smilacina racemosa.. smilacinae Felt, C. 860

ee Scutellum fuscous yellowish, basal segments of posterior tarsi yellowish; reared from subglobose stem galls on Helianthus......globulus O. S., C. 854, 856, 869

eee Scutellum fuscous orange; legs light brown; reared from galls on unknown plant in Arizona.................. baroni Felt, C. 865

eeee Scutellum yellowish brown

f Legs yellowish brown; reared from galls on Artemisia artemisiae Felt, C. 861

eeeee Scutellum dark brown

ff Legs dark brown; reared from woolly apical bud galls on Antennaria...antennariae Whlr. C. 870

dd Abdomen reddish brown

e Scutellum fuscous orange; reared from galls on Vernonia noveboracensis......vernoniae Felt, C. 863, 867

ee Scutellum dark reddish brown; reared from loose terminal bud galls on Ceanothus....ceanothi Felt, C. 872

ddd Abdomen dark brown or fuscous

e Scutellum yellowish brown or fuscous yellowish

f Third antennal segment with a length six times its diameter, posterior tarsi dark brown, length 4 mm; reared from bud galls on Hydrangea............ hydrangeae Felt, C. 852

ff Third antennal segment with a length five times its diameter, tarsi fuscous yellowish, length 3 mm; reared from distorted fruit of Thalictrum........ thalictri Felt, C. a2211

fff Third antennal segment with a length four times its diameter, posterior tarsi with the basal segments yellowish; reared from bud gall on Helenium..... autumnalis Beutm.. C. 853, 1238

ee Scutellum dark brown, abdomen white-haired; bred from twig gall on Atriplex................................ atriplicis Ckll., C. 864, 945

eee Scutellum dark reddish, legs black

f Wings broad, densely haired; reared from greenish bud gall on Sambucus.......................... sambuci Felt, C. a1511

ff Wings narrow, sparsely haired; reared from bud gall on Diplacus...........d i p l a c i Felt, C. a2318

eeee Scutellum slaty gray, legs dark brown

f Wings short, broad, terminal palp segment not tapering; reared from Diervilla buds................. d i e r v i l l a e Felt, C. a1469

ff Wings long, rather narrow terminal palp segment long, tapering; reared from Encelia............. e n c e l i a e Felt, C. a2317

eeeee Scutellum pruinose, tibiae black; reared from bud galls on Ilicoides..............i l i c o i d e s Felt, C. a1548

dddd Abdomen brown, scutellum yellowish brown, legs dark brown; reared from Salix twigs........s a l i c t a r i a Felt, C. 859

ddddd Abdomen reddish brown, legs fuscous yellowish; reared from Solidago.......................j o h n s o n i Felt, C. 809

bbb Large species, 5 to 6 mm long

c Abdomen dark brown or dark reddish brown

d Scutellum reddish brown; reared from galls on Opuntia...... o p u n t i a e Felt, C. 848, 858, 862

cc Abdomen brown, scutellum yellowish; reared from subglobular enlarged flower heads of Helianthus..........c o n s p i c u a O. S., C. 544, 806, 808, 810, 854, 866, 869, a1679, a1697

ccc Abdomen yellowish brown, scutellum fuscous yellowish, legs yellowish brown; bred from fruitlike enlargement of prickly pear.. a r i z o n e n s i s Felt, C. 857

Asphondylia brevicauda Felt

1907 **Felt, E. P.** New Species of Cecidomyiidae II, p. 14
1908 ———— N. Y. State Mus. Bul. 124:295, 376

This species is based on one specimen collected by the late H. G. Hubbard at Fort Yuma, Ariz.

Female. Length 1.5 mm. Antennae nearly as long as the body, sparsely haired, reddish brown; 14 segments, the third with a length four times its diameter. Palp; one short, stout, irregularly oval segment. Mesonotum dark brown. Scutellum yellowish brown, postscutellum a little darker. Abdomen dark reddish brown, rather thickly haired. Wings hyaline, costa yellowish brown. Halteres pale yellowish. Legs mostly yellowish brown, the tarsal segments darker; claws long, stout, strongly curved, the pulvilli as long as the claws. Ovipositor about one-half the length of the abdomen. Type Cecid. 1040.

Asphondylia auripila Felt

1907 **Felt, E. P.** New Species of Cecidomyiidae II, p. 14
1908 ———— N. Y. State Mus. Bul. 124:294–95, 376

The gall of this species was collected by the late H. G. Hubbard on L a r r e a t r i d e n t a t a at Tucson, Ariz., January 18, 1897, adults issuing shortly and continuing to appear till February 6th.

Male. Length 2.5 mm. Antennae extending to the fourth abdominal segment, sparsely short yellow haired, dark brown; 14 segments, the third with a length four times its diameter, the terminal segment broadly rounded. Palp; one long, rather stout, irregular segment. Mesonotum brownish black, the submedian lines distinct, thickly clothed with yellowish hairs. Scutellum reddish brown with a few apical setae, postscutellum slightly darker. Abdomen reddish brown, the second and following segments thickly clothed with long, yellowish hairs. Wings hyaline, costa light brown. Halteres reddish brown, pale yellowish distally. Pleurae and coxae reddish brown, the femora, tibiae and tarsi a variable yellowish brown, the distal tarsal segments reddish brown; claws long, stout, broadly rounded, the pulvilli as long as the claws. Genitalia; dorsal plate broad, deeply and triangularly incised, the lobes broadly rounded. Type Cecid. 851.

Fig. 13 Asphondylia auripila. Palpus of female, enlarged (original)

Female. Length 3 mm. Antennae extending to the third abdominal segment, sparsely haired, the third with a length six times its diameter, the twelvth with a length a little less than its diameter, the thirteenth with a length about half its diameter, the fourteenth greatly reduced, oblate. Palpi consisting of one long, somewhat fusiform segment tapering to an acute apex. Ovipositor about as long as the body. Other characters presumably nearly as in the male. Cecid. 851.

Asphondylia azaleae Felt

1907 **Felt, E. P.** New Species of Cecidomyiidae II, p. 14
1908 ———— N. Y. State Mus. Bul. 124:295, 376

Adults were reared in 1907 from June 15th till the 21st from unopened, brownish, fusiform buds of Azalea taken at Albany, N. Y. Normally only one larva occurs in a gall, though occasionally there may be two.

Larva. Length 4 mm, stout, pale yellowish. Head small; antennae short, stout, conic; breastbone quadridentate, the inner teeth a little shorter and well divided almost as in A. diervillae (fig. 24). The chitinized area tapers to the apical fourth of the stout shaft, an irregular arcuate expansion distally. Skin shagreened; terminal segment rather slender.

Male. Length 4 mm. Antennae nearly as long as the body thickly fine haired, light brown; 14 segments, the third with a length four times its diameter, the fourteenth with a length three and one-half times its diameter. Palp; the first segment stout, with a length three times its diameter, the second one-half longer, more slender; face fuscous yellowish, mouth-parts pale orange. Mesonotum dark

brown, the submedian lines thickly clothed with grayish hairs. Scutellum reddish brown, thickly clothed apically with long setae, postscutellum dark salmon. Abdomen dark brown, sparsely clothed with fine hairs, the segments rather thickly margined posteriorly with long setae, eighth segment mostly pale orange, genitalia fuscous; venter slightly lighter than the dorsum, the pleurae rather thickly clothed with silvery white scales. Wings hyaline, costa dark brown. Halteres yellowish white basally and apically, brown subapically. Coxae and femora fuscous yellowish, tibiae and tarsi mostly dark brown; claws long, stout, strongly curved, the pulvilli as long as the claws. Genitalia; dorsal plate short, stout, deeply and narrowly incised, the lobes subtriangular, obtuse apically.

Female. Length 4 mm. Antennae nearly as long as the body, thickly short haired, a variable fuscous yellowish, the extremities of the segments slightly darker; 14 segments, the third with a length fully five times its diameter. Palpi; the first segment long, stout, with a length two and one-half times its diameter, the second about twice the length of the first, more slender, tapering; face fuscous yellowish. Mesonotum a bronzy gray, laterally and anteriorly variably margined by dark brown, the submedian lines thickly clothed with long, grayish setae. Scutellum dark brown with numerous gray setae apically, postscutellum a deep salmon. Abdomen dark brown, thickly clothed with long, whitish hairs, the incisures deep salmon; pleurae rather thickly clothed with silvery white hairs, ventral sclerites dark brown, rather thickly clothed with short, white hairs and margined posteriorly with longer, yellowish hairs. Ovipositor about as long as the body. Type Cecid. a1481.

Asphondylia helianthiflorae Felt

1908 **Felt, E. P.** N. Y. State Mus. Bul., 124:376

The midge was reared during August and September 1907 from apparently unmodified flower heads of Helianthus strumosus taken at Highland, N. Y. It is much smaller than A. conspicua O. S. and distinctly smaller than A. globulus O. S.

Larva. Length 3 mm, slender, pale yellowish; head small. Antennae short, stout, conical; breastbone quadridentate; the inner teeth very small, separated by a round emargination, the outer teeth long, stout, conical. The heavy chitinized area extends to the anterior third, the shaft slender, irregularly chitinized and with an indistinct crescentic chitinized area posteriorly, the anterior two-thirds of the breastbone supported by irregular, faintly chitinized areas, similar though smaller areas occurring on the preceding segment; skin finely papillate. Posterior segment slender, slightly bilobed.

Exuviae. Length 5 mm, the cephalic horns stout, tapering, strongly serrate internally; the dorsum of the third or fourth abdominal segment with a uniform row of heavy, chitinous spines on the distal third, the basal half with an irregular double row of smaller spines. Terminal segment posteriorly with about 12 heavy, chitinous spines, the median ones slender and irregularly placed, the latero-ventral ones larger and apparently grouped, the basal half very scatteringly ornamented with shorter, stout spines, there being only three or four in the submedian areas.

Male. Length 4 mm. Antennae a little longer than the body, sparsely haired, yellowish brown, basal segments fuscous orange; 14 segments, the third with a length four times its diameter. Palpi; the first segment long, dilated apically, with a length about twice its diameter, the second slender, nearly three times the length of the preceding; face fuscous orange, eyes large, black. Mesonotum olive brown, the submedian lines rather thickly haired. Scutellum fuscous yellowish brown with numerous coarse setae apically, postscutellum fuscous yellowish. Abdomen rather thickly clothed with silvery hairs, dark brown, the venter thickly clothed with grayish hairs; genitalia fuscous yellowish. Wings hyaline, costa dark brown; halteres reddish brown. Coxae and base of femora fuscous yellowish, the distal portion of femora and tibiae darker, tarsi dark brown or black, except the second segment of the posterior legs, which is mostly fuscous yellowish; claws long, stout, strongly curved, the pulvilli as long as the claws. Genitalia; dorsal plate short, broad, deeply and roundly emarginate, the lobes broadly rounded.

Female. Length 4 mm. Antennae about as long as the body, sparsely haired, yellowish brown, the basal segments fuscous orange; 14 segments, the third with a length six times its diameter. Palpi; the first segment stout, broad, with a length about two and one-half times its diameter, the second slender, with a length more than twice the preceding. There is in some specimens of this sex a rudimentary third segment. Ovipositor nearly as long as the body. Other characters as in the male. Type Cecid. a1718.

Asphondylia eupatorii Felt

1911 **Felt, E. P.** Econ. Ent. Jour., 4:546–47

The midge was reared in September 1907 by Mr L. H. Weld of Illinois from a green, fleshy, stem gall on white snake root, Eupatorium urticaefolium collected at Medina, N. Y. This species is closely related to A. helianthiflorae Felt, though it may be readily separated therefrom by the coloration of the legs, the tapering apical segment of the palpi and the marked difference in the male genitalia.

It produces a green, fleshy stem gall very similar in general appearance to that of Asphondylia globulus O. S. on Helianthus but smaller and usually cracked.

Asphondylia betheli Ckll.

1907 **Cockerell, T. D. A.** Can. Ent., 39:324
1908 **Felt, E. P.** N. Y. State Mus. Bul. 124:376

This species breeds in the swollen Opuntia fruit which collapses after the exit of the flies. The gall was taken at Boulder, Col., adults emerging in May 1907. The following description was drafted from type specimens kindly donated for study by Professor Cockerell.

Gall. Length 3 cm, diameter 1.3 cm, subcylindric, a variable greenish and yellowish green.

Exuviae. Length 6 mm, light brown, the anterior horns stout, conical, the dorsum of the second or third abdominal segment with a row of stout, evenly placed spines on the posterior third and on the basal half two irregular rows of similar weaker spines with minor ones on the anterior margin. Terminal segment with an irregular row of 12 stout spines on the distal third, they being irregularly arranged in submedian and sublateral groups of three, the basal half thickly clothed with smaller, stout spines.

Male. Length 3 to 3.5 mm. Antennae about as long as the body, thickly fine-haired, dark brown; 14 segments, the third with a length six times its diameter. Palpi; the first segment stout, with a length three times its diameter, the second twice the length of the first, broadly flattened, tapering to an acute apex. Mesonotum slaty brown, the submedian lines sparsely haired. Scutellum dark brown, postscutellum yellowish brown. Abdomen dark brown, sparsely fine, whitish-haired, the venter dark brown, rather thickly clothed with fine, whitish hairs; genitalia fuscous. Wings hyaline, costa light brown; halteres yellowish basally, slightly fuscous apically. Coxae and femora basally fuscous yellowish, the distal portion of femora and tibiae on the anterior legs a variable yellowish brown, the tarsi dark brown, the posterior legs mostly a light yellowish brown; claws rather short, stout, strongly curved, the pulvilli as long as the claws. Genitalia; dorsal plate long, broad, deeply and triangularly emarginate, the lobes narrowly rounded.

Female. Length 6 mm. Antennae presumably nearly as long as the body, rather thickly fine-haired, dark brown; 14 segments, the third with a length about six times its diameter. Palpi; the first segment long, stout, with a length twice its diameter, the second nearly twice the length of the first, dilated near the middle, tapering, acute. Ovipositor one-half longer than the body. Otherwise nearly as in the male. Type Cecid. a1776.

Asphondylia fulvopedalis Felt

1907 **Felt, E. P.** N. Y. State Mus. Bul. 110:118 (separate, p. 22)
1908 ——————— N. Y. State Mus. Bul. 124:376

Adults were swept from Solidago at Westfield, N. Y., July 11, 1906.

Male. Length 2 mm. Antennae as long as the body, sparsely haired, light brown, fuscous basally; 14 segments, the third with a length about five times its diameter. Palpi; first segment small, suboval, the second broadly oval, the third twice the length of the second, swollen basally, tapering. Face fuscous. Mesonotum dark brown, the submedian lines lighter, scutellum, postscutellum and abdomen dark brown, the segments of the latter narrowly margined posteriorly with yellowish brown. Wings hyaline, costa light brown. Halteres fuscous. Legs fuscous straw, tarsal segments dull yellowish; claws stout, strongly and uniformly curved. Genitalia; dorsal plate broad, narrowly and probably deeply emarginate, the lobes broadly rounded. Type Cecid. 546.

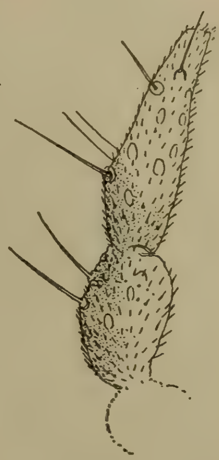


Fig. 14 Asphondylia fulvopedalis. Palpus of male, enlarged (original)

Asphondylia siccae Felt

1908 **Felt, E. P.** N. Y. State Mus. Bul. 124:376

Unripe fruit of Phyllanthus distichus, the Otaheite gooseberry, is commonly badly injured by the stout, white larvae of this species, according to Dr N. Grabham of Jamaica, W. I.

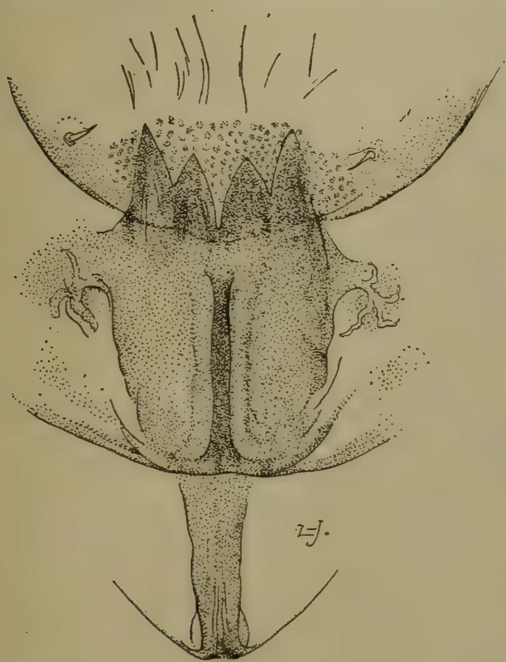


Fig. 15 Asphondylia siccae. Breastbone of larva, enlarged (original)

Larva. Length 3 mm, stout, white, the head small. Antennae stout, biarticulate, conical; breastbone quadridentate, the inner teeth much shorter than the outer and deeply divided; the heavy chitinized area rounded and extending to the basal half of the irregular shaft, which latter has a slender irregularly chitinized crescentic area posteriorly. A slightly chitinized, roughly crescentic area occurs anterior of the breastbone; skin coarsely shagreened. Terminal segment slender posteriorly, bilobed.

Exuviae. Length 5 mm, light brown, the anterior horns stout, conical, the dorsum of the second or third abdominal segment with an irregular row of stout spines on the distal third and on the basal half scattering weaker spines. Terminal segment with a transverse row of 10 spines on the distal third, the median four small, the others successively larger laterally and ventrally; the basal half with sparse smaller, stout spines.

Male. Length 2.5 mm. Antennae as long as the body, thickly short haired, light brown; 14 segments, the third with a length about five times its diameter. Palpi; the first segment with a length two and one-half times its diameter, rather stout, rounded at the extremities, the second one-fourth longer, tapering at the extremities. Mesonotum dark brown, the submedian lines sparsely haired. Scutellum yellowish brown, postscutellum a little lighter. Abdomen reddish brown, sparsely clothed with fine hairs. Wings hyaline, costa pale yellowish brown. Halteres pale yellowish. Legs a variable yellowish brown; claws short, stout, strongly curved, the pulvilli as long as the claws. Genitalia; dorsal plate short, broad, the lobes apparently divided, orbicular.

Female. Length 3 mm. Antennae extending to the fourth abdominal segment, sparsely haired, light brown; 14 segments, the third with a length five times its diameter. Palpi; the first segment short, stout, subquadrate, the second more slender, one-half longer and tapering. Ovipositor nearly as long as the body. Other characters about as in the male. Type Cecid. 1213.

Asphondylia bumeliae Felt

1907 **Felt, E. P.** New Species of Cecidomyiidae II, p. 15
1908 ———— N. Y. State Mus. Bul. 124:296, 376

The galls on Bumelia lanuginosa were collected by Dr C. L. Marlatt at Nuecestown, Texas, in May 1896, the midges appearing shortly thereafter.

Male. Length 2 mm. Antennae shorter than the body, sparsely haired, light brown; 14 segments, the third with a length five times its diameter. Palpi; the first segment long, stout, swollen distally, the second oval, the third more than twice the length of the second. Face yellowish brown. Mesonotum light brown, indistinctly margined laterally and anteriorly with yellowish, submedian lines pale yellowish, sparsely setose. Scutellum light yellow, postscutellum light brown. Abdomen thickly clothed with fine, yellowish hairs, light brown. Wings hyaline, costa dark brown. Halteres yellowish basally, fuscous apically. Legs a variable brown, the extremities of tibiae and tarsi darker; claws long, stout, evenly curved, the pulvilli shorter than the claws. Genitalia; basal clasp segment stout; the rather large, roundly triangular lobe extends beyond the insertion of the terminal clasp segment, which latter is short, obliquely

truncate and bears a pair of heavy, asymmetrical teeth; dorsal plate stout, broadly and triangularly emarginate, the lobes narrowly rounded.

Female. Length 2.5 mm. Antennae yellowish brown; 14 segments, the third with a length six times its diameter. Palpi; the first segment short, subglobose, the second broad, quadrate, the third nearly thrice the length of the second, slender, tapering. Mesonotum dark brown, narrowly margined anteriorly and laterally with yellowish. Scutellum pale yellowish, postscutellum lighter. Abdomen sparsely yellow haired, light brown, the terminal segment pale orange. Legs yellowish. Ovipositor as long as the body, otherwise nearly as in the male. Type Cecid. 849.

Asphondylia florida Felt

1908 **Felt, E. P.** N. Y. State Mus. Bul. 124:376

An unknown shrub bearing the bud galls of this species, collected by Mr E. A. Schwarz, was received from Cocoanut Grove, Fla., at the bureau of entomology, Washington, D. C., May 23, 1887, adults appearing the 25th.

Gall. The bud gall from which this specimen was reared is irregular, subglobular, about 6 mm in diameter and an empty pupal case protrudes therefrom.

Exuviae. About 3.5 mm long, rather stout, light brown, the anterior horns short, stout, conical; the dorsum of the third or fourth segment with a regular row of stout, chitinous spines on the distal third, the basal half with scattering smaller spines in two irregular rows.

Male. Length 2.5 mm. Antennae about as long as the body, sparsely clothed with fine hairs, reddish brown; 14 segments, the third with a length five times its diameter; the terminal segment subacute. Palpi; the first segment short, stout, subquadrate, the second stout, with a length two and one-half times its diameter, the third nearly twice the length of the second, somewhat swollen in the middle, slender at both extremities; face yellowish brown. Mesonotum dark brown, the submedian lines indistinct. Scutellum reddish brown, postscutellum yellowish brown. Abdomen light brown, the basal segments tinged with yellowish and sparsely haired. Wings hyaline, costa light brown; halteres yellowish basally, reddish brown apically. Legs a variable yellowish brown, the three distal tarsal segments darker; claws short, stout, strongly curved, the pulvilli as long as the claws. Genitalia; dorsal plate short, stout, slightly emarginate, the lobes widely separated, angulate. Type Cecid. 873.

Asphondylia integrifoliae Felt

1908 **Felt, E. P.** N. Y. State Mus. Bul. 124:376

This species was reared April 15, 1886 from the flowers of Sumac, Rhus integrifolia, in Los Angeles county, Cal. It evidently came from a subglobular, apparently monothalamous flower bud gall some 3 mm in diameter.

Exuviae. Length 4.5 mm, light brown, the anterior horns short, stout, subconical, the dorsum of the third or fourth abdominal segment with a regular row of stout, chitinous spines at the distal third, the basal half sparsely clothed with smaller spines. Terminal segment invisible.

Female. Length 2.5 mm. Antennae nearly as long as the body, sparsely haired, rather dark brown; 14 segments, the third with a length five times its diameter. Palpi; the first segment short, stout, subquadrate, the second slender, with a length about four times its diameter, the third a little longer than the second, more dilated, acute distally. Mesonotum dark brown, the submedian lines sparsely fine haired. Scutellum reddish brown with a few apical setae; postscutellum a little darker. Abdomen reddish brown, sparsely and finely haired; ovipositor light reddish brown. Wings hyaline, costa pale brown; halteres yellowish basally, slightly fuscous apically. Legs a variable reddish brown, the tarsi slightly darker; claws long, stout, slightly curved, the pulvilli nearly as long as the claws. Ovipositor one-fourth longer than the body. Type Cecid. 868.

A number of specimens of this sex were reared by Mr P. H. Timberlake in early June 1914 from hypertrophied flower buds of Rhus trilobata, taken near Salt Lake City, Utah, and as the galls are very similar to those from which the above-described female was reared, and the two sexes present many similarities, we have provisionally referred them to the same species.

Male. Length 2.5 to 3.5 mm. Antennae extending to the fourth abdominal segment, sparsely haired, blackish brown; 14 segments, the fifth with a length about five times its diameter, the terminal segment with a length four times its diameter. Palpi triarticulate, the first segment small, subquadrate, the second broad, with a length three times its width, the third more slender and one-half longer than the second. Mesonotum dark reddish brown. Scutellum reddish brown apically, yellowish basally, postscutellum yellowish. Abdomen grayish brown. Halteres yellowish red, fuscous apically. Coxae slate colored, the legs yellowish brown, the tibiae and tarsi mostly pale straw; claws stout, strongly curved, the pulvilli as long as the claws. Genitalia; terminal clasp segment very short, bidentate apically; dorsal plate short, divided, the lobes narrowly oval; ventral plate short, narrowly and triangularly incised and densely setose. Cecid. 1644.

Asphondylia monacha O. S.

Nun midge

1869 **Osten Sacken, R.** Amer. Ent. Soc. Trans., 2:299-301
1871 ———— Amer. Ent. Soc. Trans., 3:347
1875 ———— Can. Ent., 7:202 (A. recondita)
1886 ———— Biol. Cent. Amer. Dipt., 1:1
1907 **Beutenmueller, William.** Can. Ent., 39:305 (A. solidaginis)
1907 ———— Amer. Mus. Nat. Hist. Bul. 23:386 (A. patens)
1907 **Felt, E. P.** New Species of Cecidomyiidae II, p. 10
1908 ———— N. Y. State Mus. Bul. 124:291, 376
1908 **Jarvis, T. D.** Ent. Soc. Ont., 38th Rep't, p. 87
1909 **Felt, E. P.** Ottawa Nat., 22:246, 247, 248
1909 ———— Ent. Soc. Ont., 39th Rep't, p. 45
1909 **Jarvis, T. D.** Ent. Soc. Ont., 39th Rep't, p. 81
1910 **Stebbins, F. A.** Springf. Mus. Nat. Hist. Bul. 2:49 (Cecidomyia bifolia)

This, one of the earliest known species, is easily recognized by the white tarsal bands, especially broad on the posterior legs. One of the commonest forms, it breeds in several species of Solidago and aster. The females are abroad in June and presumably may be found ovipositing during a considerable period, since they occur in greater or less numbers from then till September or even into October. This species occurs upon a variety of Solidago, namely S. graminifolia, S. sempervirens, S. serotina and S. canadensis. It has also been reared from aster.

Osten Sacken in 1875 proposed the name of A. recondita for an Asphondylid pupa protruding from an arrested budlike growth on aster taken at Lloyds Neck, N. Y., in September. Our rearings practically establish the identity of this pupa with the species under discussion. Professor Beutenmueller, basing specific characters largely upon the type of the gall, described this species as A. solidaginis and again as A. patens. An examination of the type of the latter shows that the peculiar tarsal banding given in the original characterization is evidently an error, since the specimen agrees in every particular with A. monacha.

Gall. This species produces a variety of deformations. The most typical one in the vicinity of Albany occurs on the narrow-leaved goldenrod, Solidago graminifolia, is apical, subglobular, rather firm and from 1 to 1.5 cm in diameter, tapering distally and with the apical third consisting of rather closely appressed leaves. It resembles very closely the gall produced by Oedaspis polita Loew. During midsummer the female may deposit eggs between the leaflets of a partly developed bud of Solidago serotina or S. canadensis and thus produce

the peculiar though widely distributed adherent type of gall which consists of a slight thickening and elevation of the apposed surfaces

Fig. 16 Asphondylia monacha. *a*, breastbone of larva; *b*, cephalic horns of pupa, enlarged (original)

of two leaves. The hypertrophid tissues adhere around an oval cell some 2 mm in diameter and hold the leaves together even after the normal development of the stalk has separated their bases by an inch or more. We have reared this species from apparently unmodified Solidago florets, the chaff of the flowers being wanting, and also from a purplish green gall in the leaf axil of an aster and from arrested aster buds.

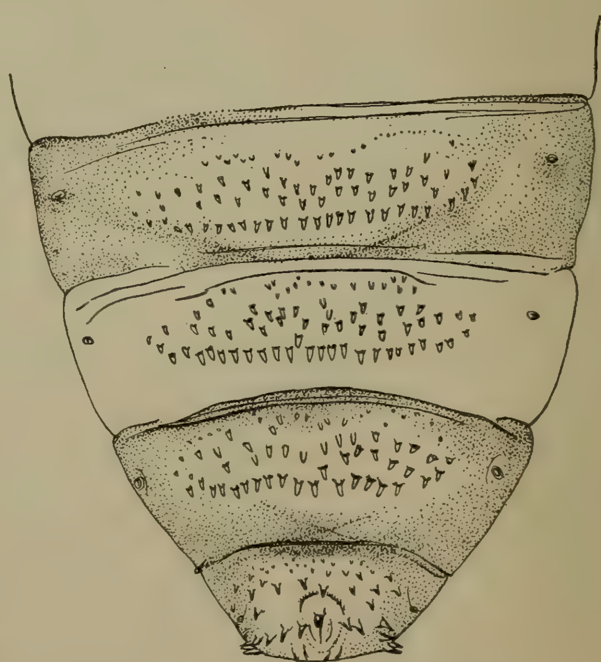


Fig. 17 Asphondylia monacha. Dorsal aspect of distal abdominal segments of exuvium, enlarged (original)

Larva. Length 3 mm, rather slender, pale yellowish; head small. Antennae small, obconic; breastbone quadridentate, the inner teeth divided and much smaller than the outer, the heavily chitinized area extending to the anterior third of the slender, irregular shaft, which dilates posteriorly into a narrow crescentic process. An irregular, slightly chitinized area supports the breastbone and a similar smaller one occurs on the preceding segment; skin minutely and sparsely papillate. Terminal segment slender, bilobed.

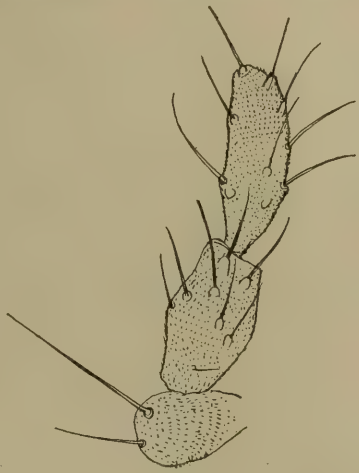


Fig. 18 Asphondylia monacha. Palpus of male, enlarged (original)

Exuviae. Length 3.5 mm, rather stout, pale yellowish, the anterior horns stout, broad, the internal curved margin serrate; dorsum of the third or fourth abdominal segment with a regular row of rather heavy, chitinous spines at the distal third, the basal half sparsely ornamented with an irregular double row of smaller spines. Terminal segment posteriorly with a row of about 10 spines, the median four small, the others laterally and ventrally successively larger, the basal half sparsely ornamented with smaller scattering spines.

Male. Length 3 mm. Antennae as long as the body, sparsely haired, dark brown; 14 segments, the fourth with a length four times its diameter. Palpi; the first segment short, stout, subquadrate, the second with a length over twice the first, swollen

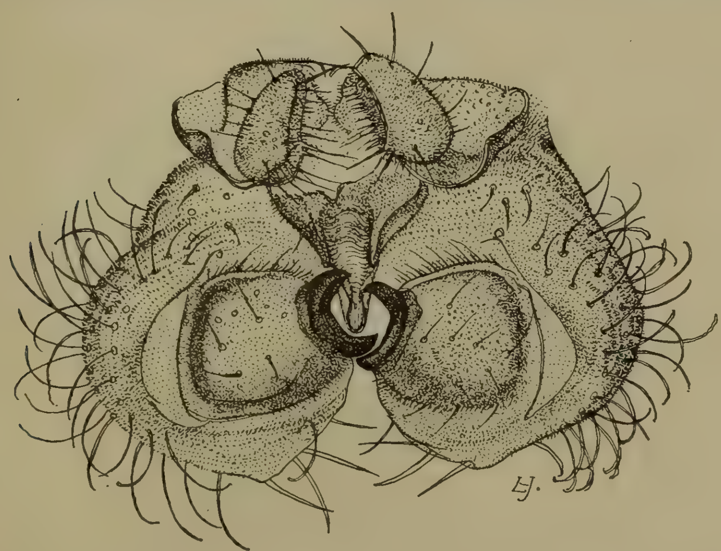


Fig. 19 Asphondylia monacha. Male genitalia, enlarged (original)

basally, tapering distally. Mesonotum slaty brown, the submedian lines lighter, thickly haired. Scutellum shining black, postscutellum yellowish brown. Abdomen thickly haired, light reddish brown.

Wings hyaline; halteres yellowish basally, fuscous apically. Coxae and base of femora fuscous yellowish, the distal portion of femora,

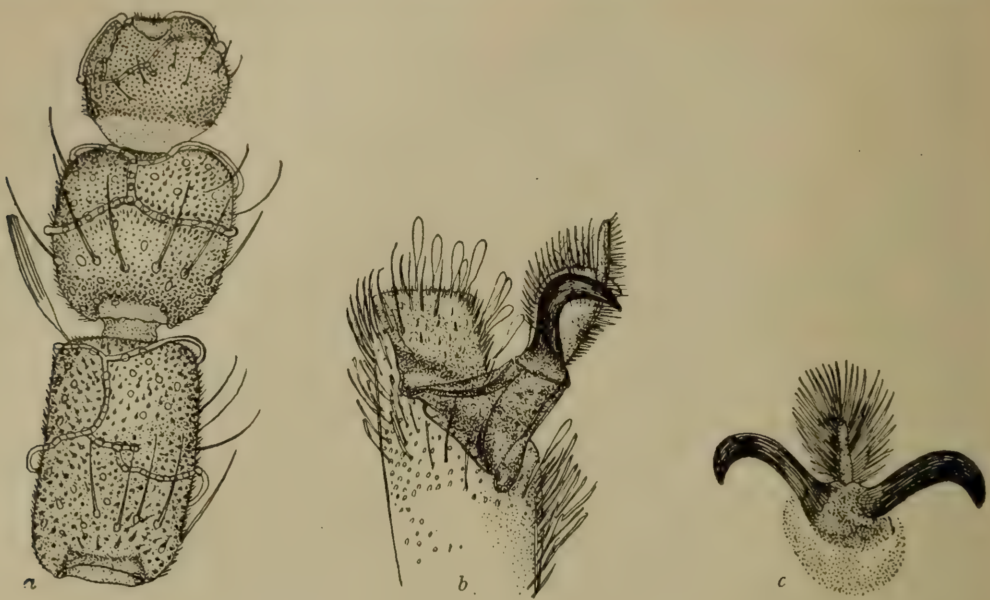


Fig. 20 Asphondylia monacha, female. *a*, distal three antennal segments; *b*, lateral view of distal portion of last tarsal segment showing claws; *c*, distal aspect of claws, enlarged (original)

tibiae and tarsi dark brown, except that femora apically is narrowly annulate with white, the first tarsal segment and the base of the second white, the markings broader on the posterior legs; claws

Fig. 21 Asphondylia monacha. Dorsal pouch at base of ovipositor, enlarged (original)

short, stout, strongly curved, the pulvilli as long as the claws. Genitalia; dorsal plate short, stout, deeply and triangularly incised, the lobes widely separated and narrowly rounded apically.

Female. Length 4.5 mm. Antennae three-fourths the length of the body, the third segment with a length five times its diameter. Palpi; the first segment rather long, the second one-half longer, slender. Scutellum dark reddish brown. Abdomen dark brown. Legs fuscous yellowish, the first tarsal segment and the base of the second dark yellowish or reddish white. Ovipositor long, otherwise nearly as in the male.

Asphondylia smilacinae Felt

1907 **Felt, E. P.** New Species of Cecidomyiidae II, p. 17
1908 ———— N. Y. State Mus. Bul. 124:298, 376

This species inhabits deformed berries of Smilacina racemosa and was taken, presumably at Washington, by Professor Barrows September 24, 1888, adults appearing September 26th to October 2d of the same year.

Male. Length 3 mm. Antennae as long as the body, rather thickly haired, light brown; 14 segments, the third with a length five times its diameter. Palpi; the first segment short, stout, subquadrate, the second stout with a length about two and one-half times its diameter, the third more slender, and nearly twice the length of the second. Mesonotum reddish brown, the sublateral areas darker and with a distinct irregular fuscous area at the anterior and posterior lateral angles, the submedian lines indistinct, dull orange, sparsely clothed with short setae. Scutellum pale yellowish, thickly clothed with short setae, postscutellum orange yellowish. Abdomen dull yellowish brown, basal segments sparsely clothed with long yellowish setae. Wings hyaline, costa light brown; halteres fuscous yellowish. Coxae and base of femora yellowish brown, the distal portion of femora, tibiae and tarsi a variable dark yellowish brown; claws long, stout, strongly curved, the pulvilli as long as the claws. Genitalia; dorsal plate short, broad, the lobes divided, roundly angulate.

Female. Length 3 mm. Antennae light brown; 14 segments, the third with a length five times its diameter. Palpi; the first segment short, stout, subglobose, the second stout, with a length nearly three times its diameter, the third long, slender, with a length fully twice that of the second; the pulvilli longer than the claws. Ovipositor hardly as long as the abdomen. Otherwise nearly as in the male. Type Cecid. 860.

Asphondylia globulus O. S.

1869 **Osten Sacken, R.** Amer. Ent. Soc. Trans., 2:301
1871 ———— Amer. Ent. Soc. Trans., 3:52
1888 **Marten, John.** Psyche, 5:102–3
1907 **Beutenmueller, William.** Amer. Mus. Nat. Hist. Bul. 23:387
1908 **Felt, E. P.** N. Y. State Mus. Bul. 124:377

This species appears to have been first observed by Mr Walsh, who transmitted it to Osten Sacken under the manuscript name of Cecidomyia helianthi-globulus. It is easily distinguished from the larger A. conspicua, according to Osten Sacken, by the paler color of its hind tibiae and tarsi. The mesonotum is distinctly lighter in color and the submedian lines more thickly haired. Furthermore, the third antennal segment of the female in this form has a length only five or six times its diameter, while in A. conspicua the length is six or seven times its diameter. The ovipositor of this species is hardly as long as the body, though in A. conspicua it is about one-fourth longer. This species occurs about New York. The gall is found on the sunflower, Helianthus giganteus, and also on H. grosse-serratus, the adults emerging in September and October.

Gall. The galls of this form occur on the Helianthus stems from a few inches to three feet above the ground. They are globular, spherical or ovate in shape and range from three-eighths to 2 inches in diameter.

Male. Length 4.5 mm. Antennae nearly as long as the body, sparsely fine haired, dark brown; 14 segments, the third with a length five to six times its diameter. Palpi; the first segment apparently short, subglobular, the second irregularly subrectangular, with a length three times its width, the third strongly compressed, slender, acute distally and with a length more than twice the preceding; face reddish brown. Mesonotum dark reddish brown, submedian lines distinct, rather thickly clothed with fine, reddish hairs. Scutellum yellowish brown, postscutellum a little darker. Abdomen yellowish brown, rather sparsely clothed with fine, yellowish hairs; genitalia dark brown. Wings hyaline, costa yellowish brown; halteres yellowish basally, slightly fuscous apically. Legs a reddish brown, the distal tarsal segments distinctly darker; claws long, stout, strongly curved, the pulvilli distinctly shorter than the claws. Genitalia; dorsal plate broad, deeply and triangularly incised, the lobes acute.

Female. Length 4.5 mm. Antennae light brown; 14 segments, the third with a length fully six times its diameter. Palpi; the first segment short, stout, subglobose, the second broader, subrectangular, with a length more than twice its diameter, the third long, slender, slightly expanded distally, about three times the length of the second; face fuscous yellowish. Mesonotum purplish brown, the submedian lines distinct, sparsely clothed with yellowish hairs. Scutellum fuscous yellowish with a few yellowish setae, postscutellum yellowish brown. Abdomen yellowish brown, thickly clothed with dark brown scales, the segments sparsely margined posteriorly with rather long, yellowish white hairs. Legs mostly a yellowish brown, the tarsi slightly darker; the pulvilli as long as the claws. Ovipositor probably as long as the body. Type Cecid. 856.

Asphondylia baroni Felt

1908 **Felt, E. P.** N. Y. State Mus. Bul. 124:377

A number of specimens were reared from galls collected by Mr O. T. Baron on some unknown plant April 8, 1888 in Arizona, adults appearing the 10th and 15th. Isorhombus arizonensis Ashm. MS and Polygnotus huachuacae Ashm. were probably reared from this gall (Insect Life, 4:125, 126)

Female. Length 3.5 mm. Antennae nearly as long as the body, sparsely fine haired, yellowish brown; 14 segments, the third with a length six times its diameter. Palpi; the first segment short, stout, subglobose, the second rather stout with a length about three times its diameter, the third slender, tapering slightly and with a length more than twice the preceding. Mesonotum grayish brown, the submedian lines dull orange, sparsely haired. Scutellum fuscous orange, postscutellum a little darker. Abdomen rather thickly clothed with short, gray hairs, light brown. Wings hyaline, costa light brown; halteres yellowish white basally, light brown apically. Legs a nearly uniform light brown, the tarsal segments narrowly annulate distally with dark brown; claws long, stout, strongly curved, the pulvilli a little shorter than the claws. Ovipositor nearly as long as the body. Type Cecid. 865.

Asphondylia artemisiae Felt

1908 **Felt, E. P.** N. Y. State Mus. Bul. 124:377

Galls of this species were taken by Mr H. K. Morrison on Artemisia at Fort Grant, Ariz., July 5, 1882, the adults issuing before they were received at the bureau of entomology, Washington, D. C.

Female. Length 4 mm. Antennae nearly as long as the body, light brown, thickly fine haired; 14 segments, the third with a length six times its diameter. Palpi; the first segment short, irregularly subglobose, the second stout, with a length nearly three times its diameter, the third one-half longer and more slender than the second. Mesonotum dark reddish brown, the submedian lines rather indistinct, sparsely haired. Scutellum yellowish brown, postscutellum a little lighter. Abdomen dark yellowish brown, being somewhat darker laterally. Ovipositor pale yellowish. Wings hyaline, costa light brown; halteres pale yellowish. Legs a variable yellowish brown, the distal tarsal segments slightly darker; claws long, rather stout, strongly curved, the pulvilli shorter than the claws. Ovipositor nearly as long as the abdomen. Type Cecid. 861.

Asphondylia antennariae Whlr.

1889 **Wheeler, W. M.** Wis. Nat. Hist. Soc. Proc., p. 209–12 (Asynapta)

1891 **Riley, C. V.** and **Howard, L. O.** Insect Life, 4:125 (Synopeas antennariae Ashm. reared)

1908 **Felt, E. P.** N. Y. State Mus. Bul. 124:377

Two gall midges produce bud galls on Antennaria plantaginifolia. Rhopalomyia antennariae inhabits a corm-shaped bud gall one-third to one-half of an inch in diameter. The sessile leaves surrounding this are somewhat succulent, broader and longer than normal, the tips being somewhat recurved and closely applied to one another like the leaves on onions. Both surfaces of the component leaves are covered with a woolly growth and there is more or less of a reddish discoloration. Frequently all the terminal buds of a plant, even a dozen or so, may become infested, the galls forming a cluster somewhat resembling a bunch of young hazelnuts.

The Asphondylia, according to Doctor Wheeler, produces a gall easily confused with that made by the Rhopalomyia. This gall is more elongate and the tips of the component leaves are scarcely recurved. The woolly growth on the under surface of the leaf is more regular, giving it a satiny appearance, while the upper surface is smooth. There is none of the reddish discoloration and but one insect occurs in a gall, occupying a smooth cavity with hard nutlike walls. The galls of Asphondylia may occur on the same plant with those of Rhopalomyia and even in the same cluster. The insect evidently hibernates in the gall, the adult emerging from its apex and appearing in the latitude of Wisconsin from about the 17th to the 20th of May. A parasite, Synopeas antennariae Ashm., was reared from this species May 31, 1888.

Male. Length 2.75 to 3 mm, the mesonotum and scutellum darker than in the female, the latter with numerous yellowish setae apically (markedly more than in the female), the abdomen dorsally with rather conspicuous lateral stripes rather thickly clothed with silvery white hairs, the terminal clasp segment of the genitalia apparently very broad, curved, the tip bidentate. Described from types in the American Museum of Natural History.

The description following is based on a specimen reared from material sent to Washington, D. C., by Doctor Wheeler in May 1888 and bearing the United States National Museum number 4288.

Female. Length 3.5 mm. Antennae about as long as the body, rather thickly fine haired, brown; 14 segments, the third with a length about five times its diameter. Palpi; the first segment short, stout, irregularly oval, the second stout, with a length about two and one-half times its diameter, the third slender, considerably swollen near the distal fourth, about twice the length of the preceding. Mesonotum dark brown, the submedian lines fuscous orange, rather thickly clothed with pale setae. Scutellum dark brown with numerous coarse setae apically, postscutellum yellowish. Abdomen brown, rather thickly clothed laterally with grayish setae, thickly so ventrally; basal pouch dark brown. Wings hyaline, costa

dark brown; halteres yellowish basally, fuscous apically. Coxae yellowish brown; femora, tibiae and tarsi dark brown, the tibiae slightly darker; claws long, somewhat slender, strongly curved, the pulvilli as long as the claws. Ovipositor about as long as the abdomen. Cecid. 870.

Asphondylia vernoniae Felt

1908 **Felt, E. P.** N. Y. State Mus. Bul. 124:377

This insect was reared October 12, 1884 from galls collected in Virginia by Mr Theodore Pergande on Vernonia noveboracensis. Females associated with this male were taken by Mr Pergande on the same plant September 21, 1885, adults issuing the following May and June.

Male. Length 3 mm. Antennae about as long as the body, thickly short haired, yellowish brown; 14 segments, the third with a length about four times its diameter. Palpi; the first segment short, stout, subglobose, the second a little longer, broadly oval, the third more than twice the preceding and tapering at both extremities. Mesonotum dark reddish brown, the submedian lines yellowish brown, thickly haired. Scutellum fuscous orange, postscutellum fuscous yellowish. Abdomen rather thickly clothed with yellowish hairs, brown. Wings hyaline, costa light brown; halteres yellowish basally and apically, reddish brown subapically. Coxae reddish brown, the femora, tibiae and tarsi mostly dark brown, the two distal tarsal segments of the middle legs at least yellowish brown and on the posterior legs, the tibiae, the first, second and base of the third tarsal segments yellowish; claws long, slender, strongly curved, the pulvilli as long as the claws. Genitalia; dorsal plate long, broad, deeply and narrowly incised, the lobes long and narrowly rounded.

Female. Length 3 mm. Antennae yellowish brown; 14 segments, the third with a length about five times its diameter; claws long, stout, strongly curved, the pulvilli nearly as long as the claws. Ovipositor a little longer than the body, otherwise nearly as in the male. Type Cecid. 867.

Asphondylia ceanothi Felt

1908 **Felt, E. P.** N. Y. State Mus. Bul. 124:377

The gall of this species was taken on Ceanothus velutinus in May 1888 at Oakland, Cal., by A. Koebele, adults issuing in June. The species was evidently reared from a large, rather loose terminal bud gall some 2 cm in length and 1.5 cm in diameter. The deformity is thickly clothed with long, linear, haired leaflets.

Female. Length 4.5 mm. Antennae extending to the fourth abdominal segment, sparsely fine haired, dark brown; 14 segments, the third with a length about six times its diameter. Palpi; the

first segment short, stout, subquadrate, the second rather stout, somewhat swollen near the basal third and with a length about three times its diameter, the third about twice the length of the second, slender and tapering gradually to an acute apex. Mesonotum dark brown, sparsely and irregularly clothed with fine setae. Scutellum dark reddish brown, postscutellum a little lighter. Abdomen dark reddish brown, nearly naked. Ovipositor pale yellowish. Wings hyaline, costa yellowish brown; halteres yellowish basally, reddish brown apically. Legs a variable light reddish brown, the distal tarsal segments slightly darker; claws long, somewhat slender, strongly curved, the pulvilli as long as the claws. Ovipositor nearly as long as the abdomen. Type Cecid. 872.

Asphondylia hydrangeae Felt

1907 **Felt, E. P.** New Species of Cecidomyia II, p. 15
1908 ———— N. Y. State Mus. Bul. 124:377

This midge was reared from bud galls on Hydrangea arborescens May 12, 1884. There appear to have been two lots referred to this number, since one bureau note records the collection of the gall by Pergande April 28, 1884, the larvae changing to pupae within the gall May 6th and adults appearing May 12th to 15th. Galls were received from Mr J. G. Barlow, Cadet, Mo., and referred to this species, all the material being in the National Museum.

Gall. An elongate, deformed bud about 1 cm in length, 3 cm in diameter, yellowish or brownish in color, the larvae living among the developing leaves.

Male. Length 4 mm. Antennae extending about to the fifth abdominal segment, thickly short yellowish haired, reddish brown; 14 segments, the third with a length six times its diameter. Palpi; the first segment short, subquadrate, the second nearly three times the length of the preceding, stout, the third one-half longer than the second, more slender; face and mouth-parts yellowish brown. Mesonotum an olive brown, the anterior lateral angles yellowish, the submedian lines rather distinct and rather thickly clothed with yellowish hairs. Scutellum yellowish brown with numerous long, yellowish apical setae, postscutellum yellowish brown. Abdomen dark brown, thickly short, yellowish or brown haired, the latter color more apparent along the median line, the hairs on the side and venter yellowish or silvery white. Wings hyaline, costa reddish brown; halteres yellowish basally, reddish brown apically. Pleurae reddish brown; coxae and femora basally yellowish brown; distal portion of the femora, tibiae and tarsi a nearly uniform dark brown; claws rather long, stout, strongly curved, the pulvilli a little longer. Genitalia; dorsal plate short, broad, deeply and triangularly incised, the lobes well separated, tapering to a narrowly rounded margin. Type Cecid. 852.

Asphondylia thalictri Felt

1911 **Felt, E. P.** Econ. Ent. Jour., 4:547

The midges were reared in some numbers August 8 to 18, 1911 from distorted seed capsules of Thalictrum collected by Miss Cora H. Clark at Magnolia, Mass. The work of this insect has also been noted at Nassau, N. Y. Specimens of presumably the same gall with exuviae were taken at Shelburne, N. H., and are in the Museum of Comparative Zoology, Cambridge, Mass. Trotteria solidaginis Felt was reared in some numbers from the same jar. The larvae of this latter species were probably preying upon the Asphondylia.

Gall. Seed capsule irregular, swollen. Length about 5 mm. The infestation is most frequently noted on account of the projecting exuviae.

Exuvium. Length about 3 mm, pale yellowish, cephalic horns long, stout, chitinous, the margins fuscous. Leg cases a variable fuscous, abdominal segments with a series of rather widely separated, chitinous teeth.

A reference to the description of the adult is given above.

Asphondylia autumnalis Beutm.

1907 **Beutenmueller, William.** Amer. Mus. Nat. Hist. Bul. 23:386
1908 **Felt, E. P.** N. Y. State Mus. Bul. 124:377

This medium-sized Asphondylia was reared from a bud gall on Helenium autumnale by Prof. William Beutenmueller who took the species in the valley of the Black mountains, North Carolina, September 6, 1906. Mr J. G. Barlow found the galls of this insect at Cadet, Mo., August 18, 1891.

Gall. " Globular or irregularly rounded with a number of aborted leaves at the apex and elations of the stems of the plant at the sides. It is green outside and white inside. Interior rather soft, pithy and somewhat succulent. . . . The gall measures from 20 to 30 mm in length and from 15 to 30 mm in width. It occurs on Helenium autumnale (Beutm.) "

The following description has been drafted from a type specimen kindly placed at our disposal by Professor Beutenmueller.

Male. Length 2.5 mm. Antennae nearly as long as the body, thickly fine haired, light brown; 14 segments, the third with a length about five times its diameter. Palpi; the first segment short, stout, subquadrate, the second stout, rectangular, with a length about three times its diameter, the third flattened, tapering distally and with a length about one-half greater than the second; face light brown.

Mesonotum dark brown, the submedian lines sparsely haired. Scutellum yellowish brown with numerous coarse setae apically, postscutellum yellowish brown. Abdomen, somewhat thickly clothed with yellowish hairs, rather dark brown or dull orange as described by Beutenmueller. Wings hyaline, costa light brown; halteres fuscous yellowish basally, fuscous apically. Coxae yellowish brown; femora, tibiae and tarsi mostly dark brown, the posterior legs with the distal portion of tibiae and the basal part of the first and second tarsal segments obscurely yellowish, each tarsal segment narrowly annulate distally with dark brown; claws long, stout, strongly curved, the pulvilli a little shorter than the claws. Genitalia; dorsal plate very short, broad, apparently divided, the lobes diverging, broadly and irregularly rounded. Type Cecid. 1238.

Asphondylia atriplicis Ckll.

1893 **Townsend, C. H. T.** Amer. Nat., 27:1021 (Cecidomyia)
1895 **Cockerell, T. D. A.** Amer. Nat., 29:766–67 (Cecidomyia)
1908 **Felt, E. P.** N. Y. State Mus. Bul. 124:377

This insect, according to Townsend, produces a fleshy, polythalamous, tumorlike, twig gall on Atriplex canescens. It was taken May 13, 1892 near Las Cruces, New Mexico.

Gall. The gall has been described as 12 mm long and 4.5 to 6 mm in diameter. It is smooth, pale greenish becoming more or less reddish when dry. The gall is rather oblong, more or less irregular in shape, fleshy green, tumorlike and occurs on one side of the twig which is more or less surrounded by the gall. The galls are normally bilocular, each cell being 2 by 3 mm in diameter.

Exuviae. Length 4.5 mm, light brown, the cephalic horns, long, stout, subapically and mesially rounded and finely serrate; dorsum of the third or fourth abdominal segment with a regular row of moderately stout, chitinous spines on the distal third, the basal half sparsely and irregularly clothed with smaller spines; terminal segment with a posterior row of about ten rather weak, chitinous spines, the latero-ventral ones stouter, the basal half with sparse, much weaker spines.

Female. Length 4.5 mm. Antennae as long as the body, sparsely fine haired, pale yellowish; 14 segments, the third with a length about five times its diameter. Palpi; the first segment short, stout, subquadrate, the second rather stout with a length nearly three times its diameter, the third nearly twice the length of the preceding, greatly dilated near the middle and tapering apically to an acute apex. Mesonotum slaty gray, the submedian lines dark gray and sparsely clothed with fine, whitish hairs. Scutellum a variable dark brown, postscutellum yellowish. Abdomen rather thickly clothed with grayish hairs, dark brown. Wings hyaline, costa light brown, subcosta uniting with the margin near the basal third; halteres pale yellowish, basally, yellowish white apically; coxae dark brown; femora, tibiae and tarsi yellowish white, the distal tarsal segments

light brown; claws long, stout, strongly curved, the pulvilli nearly as long as the claws. Ovipositor nearly as long as the abdomen. Cecid. 864.

Asphondylia neomexicana Ckll.

1896 **Cockerell, T. D. A.** N. Y. Ent. Soc. Jour., 4:204 (Cecidomyia)

This species was taken by Professor Cockerell in the Organ mountains, New Mexico, at an elevation of 5100 feet and was also common on Tularosa creek. The adult, he states, resembled A. atriplicis Twns. though the gall is quite different. There is an excellent series of galls in the Museum of Comparative Zoology, Cambridge, Mass. It may prove identical with the preceding species.

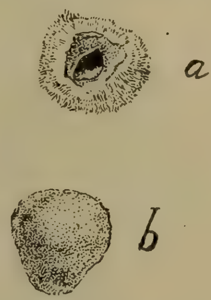


Fig. 22 Asphondylia neomexicana. Gall; *a*, section; *b*, external aspect (original)

Asphondylia sambuci Felt

1908 **Felt, E. P.** N. Y. State Mus. Bul. 124:377

This female was reared from a greenish white bud gall apparently on elder, Sambucus, sent to this office June 10, 1907 by Miss E. G. Mitchell of Washington, D. C.

Gall. This gall is irregularly subglobular, about 1.5 cm in diameter, green, hoary white with three thickened, projecting green bracts, each subtriangular in shape and about 1.5 cm long.

Female. Length 4.2 mm. Antennae nearly as long as the body, sparsely haired, dark brown, the basal segments yellowish; 14 segments, the third with a length fully five times its diameter. Palpi; the first segment short, stout, subquadrate, the second stout, with a length fully four times its diameter, the third one-half longer than the second, tapering at both extremities; face silvery between the antennae, whitish beneath, a tuft of black hairs at the middle. Mesonotum dark brown, cinereous, with the submedian lines sparsely clothed with pale hairs; laterally similar hairs margin the mesonotum. Scutellum dark reddish. Abdomen a uniform dark brown, the segments margined posteriorly with a thin row of fuscous hairs; laterally and ventrally hoary. Wings hyaline, costa dark brown; halteres

Fig. 23 Asphondylia sambuci. Gall nearly natural size (original)

dark brown, yellowish basally. Legs a uniform black with the exception of the basal third of the femora; coxae yellowish dusted with plumbeus, the first pair thickly clothed anteriorly with long, black hairs; pleurae a little darker than the coxae; claws long, stout, strongly curved, the pulvilli longer than the claws. Ovipositor about as long as the abdomen. Type Cecid. a1511.

Asphondylia diplaci Felt

1912 **Felt, E. P.** N. Y. State Ent. Soc. Jour., 20:151–52

The midges were obtained by P. H. Timberlake from a cabbage-like, densely woolly apical gall on Diplacus longiflorus collected at Whittier, Cal.

Asphondylia diervillae Felt

1897 **Felt, E. P.** N. Y. State Mus. Bul. 110:165
1908 ———— N. Y. State Mus. Bul. 124:377
1910 **Stebbins, F. A.** Springf. Mus. Nat. Hist. Bul. 2:48 (Cecidomyia inaequalis Steb.)

This medium-sized, dark-brown species infests the unopened buds of bush honeysuckle, Diervilla trifida. The first galls were taken at Albany, N. Y., May 27, 1907 and adults continued to emerge from that time until June 15.

Gall. Length 9 mm, diameter 3 mm, green, the slender tips sometimes discolored.

Larva. Length 4 mm, stout, pale yellowish, the head small; antennae short, conical; breastbone quadridentate, inner teeth decidedly shorter than the outer and well divided (figure 24). The

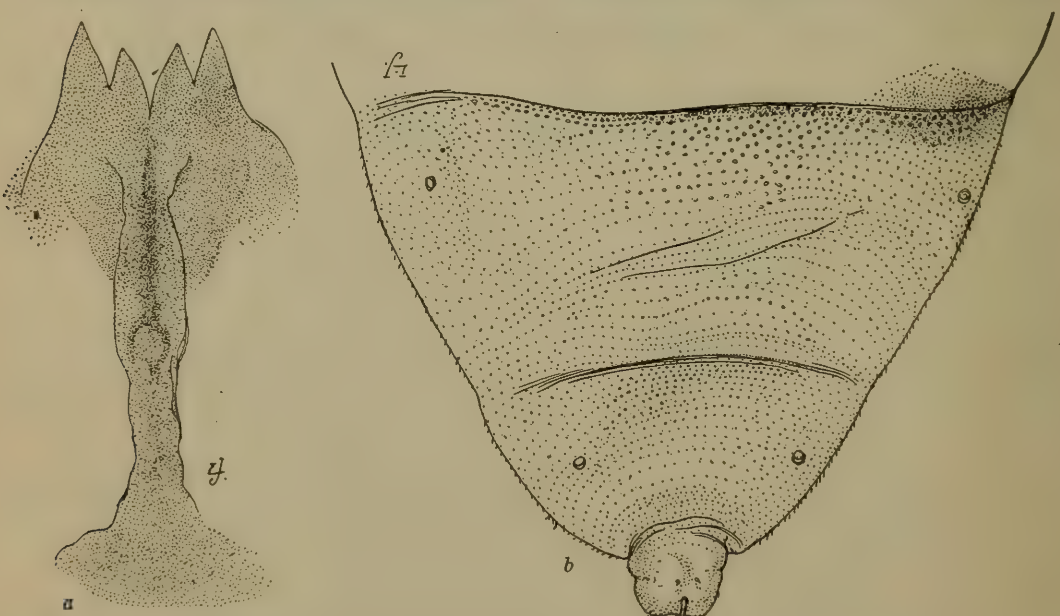


Fig. 24 Asphondylia diervillae. *a*, larval breastbone; *b*, posterior extremity of larva, enlarged (original)

heavy, chitinized area extends to the apical fourth, shaft irregular and with a weekly chitinized, crescentic area posteriorly; skin shagreened; terminal segment slender, bilobed.

Male. Length 4 mm. Antennae extending about to the fifth abdominal segment, thickly fine haired, light brown, the basal segments fuscous yellowish; 14 segments, the third with a length six times its diameter. Palpi; the first segment short, stout, subquad-

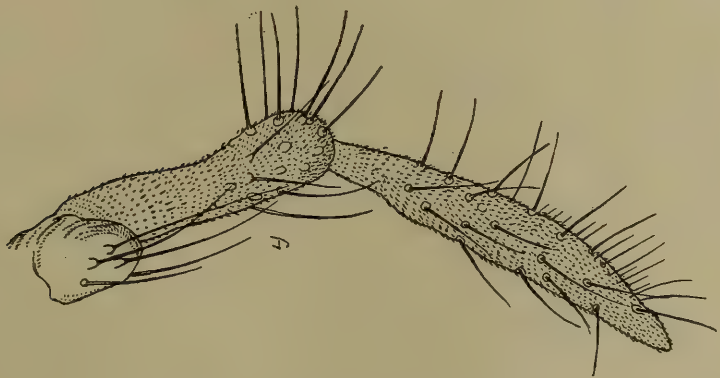


Fig. 25 Asphondylia diervillae. Palpus of female, enlarged (original)

rate, the second rather stout with a length about three times its diameter, the third twice the length of the second, tapering at both extremities; face fuscous yellowish. Mesonotum slaty brown, the submedian lines thickly clothed with long, grayish setae. Scutellum reddish brown with numerous apical setae, postscutellum a reddish salmon. Abdomen with the dorsal sclerites a nearly uniform dark brown, the incisures dull salmon; each of the segments sparsely clothed with fine hairs and margined posteriorly with long, yellowish setae. Genitalia fuscous; venter with the posterior segments rather thickly clothed with cinereous hairs. Wings hyaline, costa dark brown; halteres pale salmon basally, fuscous apically; coxae and base of femora a fuscous yellowish, the distal portion of femora, tibiae and tarsi a nearly uniform dark brown; claws long, stout, strongly curved, the pulvilli longer than the claws. Genitalia; dorsal plate apparently divided, the lobes roundly triangular.

Female. Length 3.5 mm. Antennae extending to the fourth abdominal segment, sparsely haired, grayish brown. Mesonotum dull slate color, irregularly margined laterally with long, grayish setae, the submedian lines thickly clothed with similar setae. Scutellum slaty gray with long setae apically, postscutellum fuscous yellowish. Abdomen a nearly uniform dark brown, the segments sparsely margined posteriorly with long, grayish setae; pleurae and abdomen rather thickly clothed with yellowish white setae; coxae a dull gray, the pulvilli as long as the claws. Ovipositor about as long as the body, otherwise nearly as in the male. Type Cecid. a1469.

Asphondylia enceliae Felt

1912 **Felt, E. P.** N. Y. Ent. Soc. Jour., 20:152

Several midges were reared February 23 and 25, 1911 from leaf bud galls on Encelia californica collected by P. H. Timberlake in the Puente hills, Whittier, Cal. The species runs in our key to A. ilicoides Felt from which it is easily separated by the relatively much longer and narrower wings.

Asphondylia ilicoides Felt

1907 **Felt, E. P.** New Species of Cecidomyiidae II, p. 15–16
1908 ——— N. Y. State Mus. Bul. 124:296–97, 377

The small, oval, green bud galls on Ilicoides mucronata made by this form are about 5 mm long, 3 in diameter, each inhabited by several larvae and were taken at Old Forge, N. Y., June 20, 1907, several adults being obtained the latter part of the month. The species appears to be quite subject to attacks by parasites.

Gall. An oval, green bud gall 5 mm long.

Male. Length 3 mm. Antennae nearly as long as the body, sparsely short haired, dark brown, the basal segment pale at the base; 14 segments, the third with a length fully three times its diameter, slightly swollen at the base. Palpi pale yellowish, the first segment very short, stout, subquadrate, the second rather long, stout, with a length fully three times its diameter, the third a little longer than the second, somewhat constricted at the base, tapering, subacute. Mesonotum brown dusted with pruinose, the submedian lines sparsely clothed with gray setae and a lateral row of setae in front of the wing insertion; pleurae concolorous with the mesonotum. Scutellum concolorous with the mesonotum, thickly clothed with long, gray setae. Abdomen dark brown dorsally, sparsely clothed with gray setae which are apparently longer posteriorly; ventrally the abdomen is yellowish red, rather thickly clothed with short, shining, gray hairs. Wings hyaline, costa dark brown; halteres pale basally, fuscous subapically, slightly so apically; coxae and the basal two-thirds of the femora luteous, the latter shading to a very dark brown apically; tibiae and tarsi black, the anterior legs similarly colored; the midlegs have the femora quite a little darker at the base; claws stout, strongly curved, the pulvilli as long as the claws. Genitalia; dorsal plate short, stout, deeply and narrowly incised, the lobes broadly rounded.

Female. Length a little less than 3 mm. Antennae nearly as long as the body, sparsely haired, dark brown; 14 segments, the third with a length fully five times its diameter. Colorational characters about as in the opposite sex, except that the abdomen is more thickly clothed with gray hairs, giving it a gray appearance. Ovipositor nearly as long as the body, otherwise nearly as in the male. Type Cecid. a1548.

Asphondylia salictaria Felt

1907 **Felt, E. P.** New Species of Cecidomyiidae II, p. 16–17
1908 ———— N. Y. State Mus. Bul. 124:297–98, 377

Willow twigs infested by this species were collected by Mr J. H. Jackson at Pleasantville, Ind., May 6, 1889, the adults appearing May 15th.

Exuviae. Length 5 mm, the cephalic horns absent in the preparation, the dorsum of the third or fourth abdominal segment with a regular row of small spines at the distal third, the basal half sparsely ornamented with smaller, widely scattered spines; the terminal segment with a posterior row of 11 or 12 spines, there being a median group of five small ones, the basal half sparsely ornamented with scattering, smaller spines. This species has the spines relatively much less developed than in many other forms.

Female. Length 3.5 mm. Antennae about as long as the body, thickly fine haired, yellowish brown; 14 segments, the third with a length fully six times its diameter. Palpi; the first segment short, stout, subquadrate, the second stout, with a length fully three times its diameter, the third a little longer than the second, curved and dilated apically. Mesonotum dark brown, the submedian lines fuscous yellowish, thickly clothed with long setae. Scutellum yellowish brown with numerous coarse setae apically, postscutellum dull yellowish white. Abdomen brown, rather thickly clothed with fine setae, the segments variably margined posteriorly with whitish setae, the basal segment margined anteriorly and posteriorly with silvery white; venter thickly clothed with silvery hairs. Wings hyaline, costa light brown; halteres yellowish basally, fuscous apically. Coxae and base of femora fuscous yellowish, distal portion of femora, tibiae and tarsi dark brown; claws long, stout, strongly curved, the pulvilli longer than the claws. Ovipositor hardly the length of the abdomen. Type Cecid. 859.

Asphondylia johnsoni Felt

1908 **Felt, E. P.** N. Y. State Mus. Bul. 124:377
1909 ———— Ottawa Nat., 22:246

This insect was reared from Solidago at Lansdown, Pa., July 28th by Prof. C. W. Johnson.

Exuviae. Length 5 mm, light brown, rather slender, the cephalic horns long, stout, conical, the dorsum of the third or fourth abdominal segment with a transverse row of uniform, heavy, chitinous teeth on the distal third, the basal half with a somewhat irregular transverse row of smaller, somewhat irregular teeth and a rudimentary scattering row just anteriorly; terminal segment posteriorly with a row of about eight heavy, chitinous teeth, the latero-ventral

ones larger, the basal half scatteringly and rather uniformly clothed with heavy, chitinous teeth.

Male. Length 4 mm. Antennae presumably as long as the body, sparsely haired, light brown; 14 segments. Palpi; the first segment short, stout, subquadrate, the second stout, with a length about three times its diameter, the third long, slender, tapering distally and with a length about twice the second; face reddish yellow. Mesonotum smooth, reddish brown. Scutellum fuscous yellowish, postscutellum a little lighter. Abdomen rather thickly clothed with long, yellowish hairs, reddish brown. Wings hyaline, costa yellowish brown. Halteres yellowish basally, fuscous apically. Legs fuscous yellowish, the distal tarsal segments darker; claws rather long, stout, strongly curved, the pulvilli as long as the claws. Genitalia; dorsal plate short, stout, deeply and triangularly emarginate, the lobes broadly rounded. Type Cecid. 809.

Asphondylia opuntiae Felt

1908 **Felt, E. P.** N. Y. State Mus. Bul. 124:377
1912 **Hunter, W. D., Pratt, F. C., Mitchell, J. D.** U. S. D. A. Bul. 113:34

This is a large, dark brown form occurring on Opuntia, and judging from the records, a relatively abundant species. The galls from

Fig. 26 Asphondylia opuntiae. Breastbone of larva, enlarged (original)

which this insect was reared were collected at Sinton, Texas, March 26, 1906 by J. D. Mitchell. Apparently the same form was taken

by Messrs Dyar and Caudell on Cactus in Colorado, flies appearing June 2d. Specimens reared from Opuntia at Los Angeles, Cal., April 11, 1908, at Beeville, Texas, March 7, 1908, at Ash Fork, Ariz., June 5, 1906 and in the Organ mountains May 17, 1905, were received from Mr W. D. Hunter of the bureau of entomology. Evidently this species has a wide distribution in the southwestern states.

Larva. Length 6 mm, rather stout, presumably yellowish white; breastbone bidentate, the teeth heavy, broad, triangular, the heavy, chitinized portion tapering from the base of the teeth to the anterior third, thence a rather stout, uniform process extending to the posterior extremity which is expanded as a weakly chitinized lunate piece. The anterior half of the breastbone is supported by a weakly chitinized irregularly oval area and by a similar weakly chitinized irregularly trapezoidal area on the anterior segment; skin slightly shagreened, the anal segment slender, bilobed.

Exuviae. Length 6 mm, cephalic horns long, stout, conical, the third or fourth abdominal segment with a very uniform row of heavy, stout spines on the distal third, the basal half with three irregular rows of stout spines; terminal segment with a posterior row of eight spines, the four median ones smaller, the others larger, the basal half with smaller, scattering spines.

Male. Length 4 mm. Antennae nearly as long as the body, sparsely fine haired, dark brown; 14 segments, the third with a length fully six times its diameter; terminal segment slightly prolonged and bearing a small apical knob. Palpi very small, indistinct; face yellowish white. Mesonotum a slaty brown, the sublateral areas distinctly lighter, submedian lines rather indistinct, sparsely clothed with fine hairs. Scutellum a slaty brown with a few yellowish setae apically, postscutellum fuscous yellowish. Abdomen dark brown, sparsely clothed with fine, silvery hairs, the incisures pale yellowish. Wings hyaline, costa dark brown; halteres yellowish basally and apically, brown subapically. Pleurae and coxae basally dark brown. Legs a variable light brown, tarsi slightly darker; claws stout, strongly curved, the pulvilli a little longer. Genitalia; dorsal plate short, broad, the lobes divided, irregularly subquadrate.

Female. Length 6 mm. Palpi; the first segment short, roundly subquadrate, the second stout, subrectangular, with a length over twice its diameter, the third longer, slender, irregularly fusiform; face yellowish. Mesonotum very dark brown, submedian lines indistinct, sparsely clothed with fine setae. Scutellum reddish brown, postscutellum a light fuscous yellowish with a dark brown, submedian area. Abdomen dark brown, very sparsely clothed with fine setae, the ovipositor dark reddish brown; halteres fuscous yellowish basally, light yellowish apically; the distal tarsal segments narrowly and rather indistinctly annulate with dark brown. Ovipositor longer than the body, otherwise nearly as in the male. Type Cecid. 848.

Asphondylia conspicua O. S.

1871 **Osten Sacken, R.** Amer. Ent. Soc. Trans., 3:51–52
1907 **Beutenmueller, William.** Amer. Mus. Nat. Hist. Bul. 23:387
1907 **Cook, M. T.** Acad. Sci. Proc. Sep., p. 6
1908 **Felt, E. P.** N. Y. State Mus. Bul. 124:377
1910 **Stebbins, F. A.** Springf. Mus. Nat. Hist. Bul. 2:54

This large midge frequently attains a length of 5 or 6 mm and makes a very large gall on the flower heads of Rudbeckia triloba. It is closely related to A. globulus O. S. from which it is easily distinguished, according to Osten Sacken, by the darker color of the hind tibiae and tarsi, though in our own series we have failed to find this character of much service. A more striking feature is the much darker mesonotum. A comparison of type specimens in the Museum of Comparative Zoology at Cambridge, Mass., showed that these two species are probably distinct though closely related. There may be some difference in the pupal armature. Our studies of material reared from a typical gall show that in A. conspicua the male palpi are three-segmented, the third antennal segment has a length about six times its diameter and that of the female a length of seven times its diameter. There are also differences in the male genitalia. The gall was taken at Bath, Rensselaer county, N. Y., August 16, 1907 and was received from High-

Fig. 27 Asphondylia conspicua. Breastbone of larva, enlarged (original)

spire, Pa., August 17th; adults emerged from August 24th to 30th. Specimens doubtfully referred to this species were taken in a trap lantern at Newport, N. Y., July 2, 1906; captured by Prof. C.

W. Johnson at Philadelphia, Pa., August 14 and 20, 1891; taken at Westville, Conn., by Dr W. E. Britton, September 14, 1904 and reared August 8, 1882 from galls on Rudbeckia laciniata and collected by Mr Turner July 31, 1882 at Piney Branch, D. C. Torymus species was reared from this midge.

Gall. The gall is an irregular, subglobular swelling caused by an abnormal enlargement of the flower heads. It may be 5 cm in diameter and here and there with small leaflets on the surface (plate 15, figure 2). A number of larvae occur in a gall.

Larva. Length 4.5 mm, stout, yellowish; head small. Antennae very short, conical; breastbone (figure 27) quadridentate, the inner teeth rudimentary, widely separated, the other pair large, the anterior chitinous area extending to the cephalic fourth, the shaft irregular, slightly dilating distally and with inconspicuous lateral prolongations at its extremity; the skin minutely papillate and slightly shagreened; terminal segment with a relatively small, lobulate process posteriorly.

Exuviae. Length 6 mm, light brown; anterior horns stout; conical, the dorsum of the second or third abdominal segment with a row of stout, evenly placed, chitinous spines and on the distal third and on the basal half two irregular rows of rather heavy, chitinous spines with scatterings, smaller ones anteriorly. Terminal segment with an irregular row of stout spines on the distal third, the lateral and ventral ones stouter and more irregular, the basal half with smaller spines.

Male. Length 5 mm. Antennae nearly as long as the body, thickly fine haired, dark brown, the basal segment reddish yellow; 14 segments, the third with a length about six times its diameter. Palpi; the first segment short, stout, subquadrate, the second more than twice the length of the first, stout, the third about two and one-half times the length of the second, rather slender. Mesonotum slaty brown, the submedian lines broad, dull orange, rather thickly clothed with short setae. Scutellum brownish yellow with a few coarse setae apically, postscutellum yellowish. Abdomen yellowish brown, rather thickly clothed with short, yellowish brown hairs, the pleurae and venter thickly clothed with silvery hairs; genitalia dull orange. Wings hyaline, costa light brown; halteres yellowish basally, a variable fuscous apically. Coxae dull orange; femora and tibiae dark brown and yellowish, the tarsi usually somewhat darker, the posterior legs with the femora and tibiae decidedly lighter and the basal tarsal segments mostly a dull yellowish, the fifth segment a variable brown; claws long, rather stout, strongly curved, the pulvilli as long as the claws. Genitalia; dorsal plate short, stout, broadly and roundly emarginate, the lobes broadly rounded.

Female. Length 6 mm. Antennae; 14 segments, the third with a length about seven times its diameter. Mesonotum grayish dark brown, the submedian lines rather indistinct, thickly clothed with fine hairs. Scutellum dark brown with a few coarse setae, postscutellum fuscous yellowish. Abdomen rather thickly clothed with

long, yellowish brown hairs, dark brown, the pleurae and venter thickly clothed with silvery gray hairs. Ovipositor about one-fourth longer than the abdomen. Cecid a1697.

Asphondylia arizonensis Felt

1907 **Felt, E. P.** New Species of Cecidomyiidae II, p. 13
1908 ———— N. Y. State Mus. Bul. 124:294, 377

This large species breeds in fruitlike enlargements of the prickly pear or Cactus. The galls were taken by Mr H. K. Morrison at Fort Grant, Ariz., and were received at the bureau of entomology May 5, 1882 and figured in "Nature" for November 23, 1882, page 77. The figure referred to illustrates a somewhat pear-shaped gall about 16 cm long and 8 cm in diameter. Mr Morrison states that this gall appears to be rare, though the species of Cactus upon which it occurs is abundant. All the galls he observed were on one plant and contained hundreds of larvae May 5th. Pupae had forced their way out, some even penetrating the stout paper in which the galls were wrapped; the living adults were characterized as being dark gray with black eyes, the legs and halteres reddish. Koebele reared this species from seed pods of Cactus at Los Angeles, Cal., in March 1886. Another lot of supposedly the same species was received May 31, 1899 from Bayfield, Col., through C. F. Baker and adults, as in the previous case, issued during transit.

Gall. The galls are very large and resemble somewhat the fruit of the prickly pear. They are yellowish and in places somewhat rose colored, without thorns, except at the base, very fleshy and decay easily.

These data have been drafted from the notes of the bureau of entomology kindly placed at our disposal.

Male. Length 4.5 mm. Antennae a little longer than the body, sparsely haired, light brown; 14 segments, the third with a length five times its diameter. Palpi; the first segment with a length two and one-half times its diameter, the second as long as the first, more slender, the third one-half longer than the second. Mesonotum dark brown, nearly naked. Scutellum pale yellowish, postscutellum reddish brown. Abdomen rather thickly clothed with yellowish hairs, light brown, the eighth segment light yellowish. Genitalia fuscous. Wings hyaline, costa light brown. Halteres pale yellowish. Legs yellowish brown, the distal tarsal segments reddish brown; claws long, stout, strongly curved, the pulvilli as long as the claws. Genitalia; dorsal plate broad, broadly and triangularly incised, the lobes subtruncate.

Female. Length 5 mm. Antennae as long as the body, thickly haired, light yellowish brown; 14 segments, the third with a length six times its diameter. Palpi; the first segment short, stout, fusiform, the second a little longer, rectangular, the third about twice the

length of the second, more slender. Mesonotum grayish brown, the submedian lines thickly haired. Scutellum light fuscous yellowish, postscutellum lighter. Abdomen thickly clothed with fine, grayish

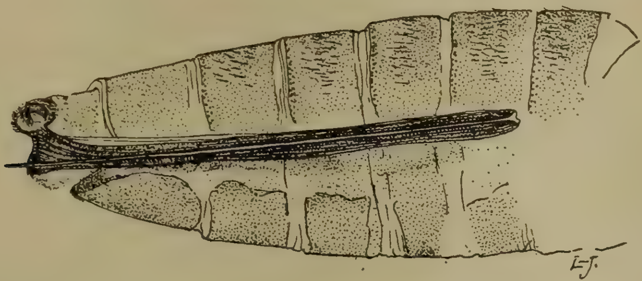


Fig. 28 Asphondylia arizonensis. Side view of abdomen showing ovipositor in retracted position, enlarged (original)

hairs, light yellowish brown, the eighth segment yellowish, the lobes dark brown. Ovipositor one-half longer than the body, otherwise nearly as in the male. Type Cecid. 857.

Asphondylia prosopidis Ckll.

1898 **Cockerell, T. D. A.** Ann. Mag. Nat. Hist., 7th ser., 2:329–30

Galls of this insect were met with by Professor Cockerell at Mesilla Park, N. M., and consist of the aborted fruits of Prosopis juliflora var. glandulosa. "They hang on the stalk something like grapes and are subglobose with a pointed apical projection which represents the end of the pod. The globose portion is about 8 mm long and 7 broad, the pointed portion about as long or shorter. Color green, becoming yellowish and tinged with red." The pupal shell is a reddish brown, and adults emerged August 13, 1898.

Professor Cockerell states that this species differs from A. neomexicana in the dark, instead of pallid, second nervure and the impressed lines of the thorax being feebly or not pubescent. The life history is quite different.

Asphondylia mentzeliae Ckll.

1900 **Cockerell, T. D. A.** Ent., 33:302

The larvae of this species occurred in the ovaries of Mentzelia multiflora at Raton, N. M., August 27, 1900, causing the flowers to wither. The pupal shells are red-brown and protrude over the sides of the flower.

Asphondylia attenuatata Felt

1909 **Felt, E. P.** Ent. News, 20:300-1

This West Indian species was reared in some numbers by Prof. H. A. Ballou, government entomologist, from flower buds and flowers of privet or wild coffee, Clerodendron aculeatum. The male is peculiar on account of the slender, somewhat produced antennae, the flagellate segments being provided with unusually small and indistinct circumfili.

Asphondylia pattersoni Felt

1911 **Felt, E. P.** Ent. News, 22:301

This reddish brown midge was reared February 3, 1911 by Mr W. H. Patterson, St Vincent, W. I., from the flowers of fiddlewood, Citharexylum quadrangulare.

Asphondylia vincenti Felt

1911 **Felt, E. P.** Ent. News, 22:109-10

This species was reared by Mr W. H. Patterson from the fruits of Jussiaea linifolia and J. suffruticosa at St Vincent, W. I.

CINCTICORNIA Felt

1908 **Felt, E. P.** N. Y. State Mus. Bul. 124:379
1911 ———— N. Y. Ent. Soc. Jour., 19:48
1913 **Kieffer, J. J.** Gen. Insect., fasc. 152, p. 90
1915 **Felt, E. P.** U. S. Nat. Mus. Proc. 48:197

This genus comprises a group of very characteristic forms originally supposed by the writer to be cogeneric with Polystepha Kieff. Specimens of C. multifila Felt were submitted to this well-known European authority, who pronounced it a representative of a new genus and consequently this name was proposed. Asphondylia transversa Felt is the type.

Antennae consisting of 13 or 14 very rarely 15 sessile or subsessile, greatly produced, cylindric segments. There is a distinct tendency toward reduction and certain species have but 13 segments, while others may have the thirteenth and fourteenth greatly reduced. The flagellate segments of the male are provided with from 2 to 15 low, distinct, anastomosing circumfili which girdle the greater part of the segment from near the basal fourth to its apex. Normally, the number of circumfili vary from 6 to 15, while in the synthetic C. simpla and C. connecta we have but 2 circumfili, basal and apical, and a rather well-developed broad band of long

setae so characteristic of Lasioptera, Dasyneura and their allies. The flagellate segments of the female may have from 2 to 5 or 6 anastomosing circumfili, forming a more or less irregular network on the face of the segment, the more generalized species, C. simpla and C. connecta having, as in the male, a somewhat well-developed subapical band of long setae. Palpi composed of 4 segments; the wings are of the usual Asphondylid type; the claws are simple, the pulvilli usually being shorter than the claws. The genitalia are very characteristic, the terminal clasp segment being short, stout and curving to a broad, heavily chitinized, denticulate apex; the dorsal and ventral plate, as in Asphondylia are relatively small. The ovipositor is rather long, relatively stout, composed of a rather heavy, tapering basal segment and a more slender apical segment, peculiar on account of the thickened chitin along its ventral margin, and apically provided with a pair of small, setose lobes. This organ is distinctly more generalized than the highly developed ovipositor of Asphondylia and Schizomyia.

Fig. 29 Cincticornia species. Fourth antennal segment of female, enlarged (original)

This genus comprises, as our rearings show, mostly, if not entirely, oak insects. The rather stout, yellowish or orange larvae winter in the gall and prior to transformation escape therefrom, enter the soil and spin a loose cocoon with particles of leaves or sand adhering thereto. The adults in nature probably appear in early June at the time the young oak leaves are developing. The galls, so far as we know, are all confined to oak leaves, the more highly specialized forms producing more or less thick-walled, sometimes compound deformations of leaf tissues, while one at least of the generalized forms lives in a relatively inconspicuous cell lying between the slightly thickened epidermal layers. It is possible that further study will result in finding members of this genus inhabiting the leaves of some other plants.

Key to species

a Wings small (2.5 mm long or less)
- *b* Wings relatively long and narrow
  - *c* Abdomen dark brown
    - *d* Male; length 1.25 mm, scutellum reddish brown, fifth antennal segment with 10 to 12 circumfili...................... transversa Felt, C. 53

dd Male; length 2 mm, scutellum fuscous yellowish, the fifth antennal segment with 8 circumfili. Reared from circular blister gall on scarlet oak ....serrata Felt, C. a1791

cc Abdomen reddish brown

d Male; length 3 mm, scutellum yellowish, antennae with 13 segments, the fifth with 10 circumfili. Recorded as reared from conic hickory leaf gall..............caryae Felt, C. 1114

dd Male; length 1.5 mm, scutellum yellowish, fifth antennal segment with 10 to 15 circumfili. Female; length 1.5 mm, the fifth antennal segment with a length three times its diameter and 4 coarsely anastomosing circumfili. Reared from flat, inconspicuous gall on red oak leaves......................
quercifolia Felt, C. 1043

ccc Abdomen dark reddish orange

d Male; length 2 mm, scutellum fuscous yellowish, the fifth antennal segment with 8 to 9 circumfili. Female; abdomen mostly dark reddish orange, the fifth antennal segment with a length four times its diameter and with 4 coarsely anastomosing circumfili. Reared from circular, pustulate oak leaf gall.....
pustulata Felt, C. a1789, 850

bb Wings relatively short and broad

c Abdomen dark brown

d Male; length 2 mm, scutellum reddish brown, the fifth antennal segment with a length two and one-half times its diameter; but 2 stout circumfili and a subapical band of long setae. Female; length 2 mm, the fifth antennal segment with a length three and one-half times its diameter. Reared from oval, pustulate red oak leaf gall...............................
simpla Felt, C. a1942, a1789d, a1903, a 1947

dd Male; length 2.75 mm, scutellum reddish brown, the fifth antennal segment with 11 circumfili. Female; abdomen reddish orange, scutellum dark red, fifth antennal segment with a length thrice its diameter and 4 coarsely anastomosing circumfili. Reared from subglobose, nippled, brown oak leaf gall...........................globosa Felt, C. a1902

ddd Male; length 2 mm, scutellum dark brown, fifth antennal segment with 7 to 8 circumfili. Female; length 2.5 mm, fifth antennal segment with a length four times its diameter and 4 coarsely anastomosing circumfili. Reared from a midrib swelling on oak leaves.........podagrae Felt, C. a1788

dddd Male; length 2.5 mm, scutellum pale yellowish, fifth antennal segment with 9 circumfili. Female; length 2 mm, abdomen mostly deep orange, scutellum dark reddish, fifth antennal segment with a length three and one-half times its diameter and 4 coarsely anastomosing circumfili. Reared from a slight circular blister swelling on the lateral veins of red oak leaves ..
americana Felt, C. a1792

ddddd Male; length 1.25 mm, scutellum reddish brown, 13 antennal segments, the fifth with 6 to 7 circumfili...................
multifila Felt, C. 95, 99, 100

cc Abdomen yellowish orange

d Male; length .75 mm, scutellum light brown, 13 antennal segments, the fifth with a length of two and one-half times its diameter and 6 to 7 circumfili. Swept from sumac.......... r h o i n a Felt, C. 94

dd Female; length 1.25 mm, scutellum yellowish red; 13 antennal segments, the fifth with a length two and one-half times its diameter; 2 to 3 circumfili. Swept from Cornus............ c o r n i f o l i a Felt, C. 49c

aa Wings large (2.75 mm or more in length)

b Abdomen dark brown

c Male; length 3 mm, scutellum fuscous yellowish, the fifth antennal segment with 9 to 10 circumfili. Female; length 3.5 mm, the fifth antennal segment with a length two and one-half times its diameter and 4 coarsely anastomosing circumfili. Reared from warty, reddish brown oak leaf gall.......................... p i l u l a e Walsh, C. 811, 814, 1046, 1105, a1888, a1939

cc Female; length 2 mm, scutellum purplish brown, the fifth antennal segment with a length two and one-half times its diameter and 5 coarsely anastomosing circumfili, the fourth palpal segment twice the length of the third.....c a n a d e n s i s Felt, C. 1042

bb Abdomen reddish brown

c Male; length 3 mm, scutellum reddish yellow, the fifth antennal segment with a length two and one-half times its diameter, 4 coarsely anastomosing circumfili. Female; length 3.5 mm, scutellum pale yellow, fifth antennal segment with a length three and one-half times its diameter and 5 coarsely anastomosing circumfili.................................s o b r i n a Felt, C. 1108

bbb Abdomen reddish yellow

c Female; length 2.5 mm, scutellum fuscous yellowish, the fifth antennal segment with a length two and one-half times its diameter and 2 irregularly anastomosing circumfili, the distal palpal segment one-fourth longer than the third........................ c o n n e c t a Felt, C. 822

Cincticornia transversa Felt

1907 **Felt, E. P.** New Species of Cecidomyiidae, N. Y. State Mus. Bul. 110: 118 (separate p. 22) (Asphondylia)

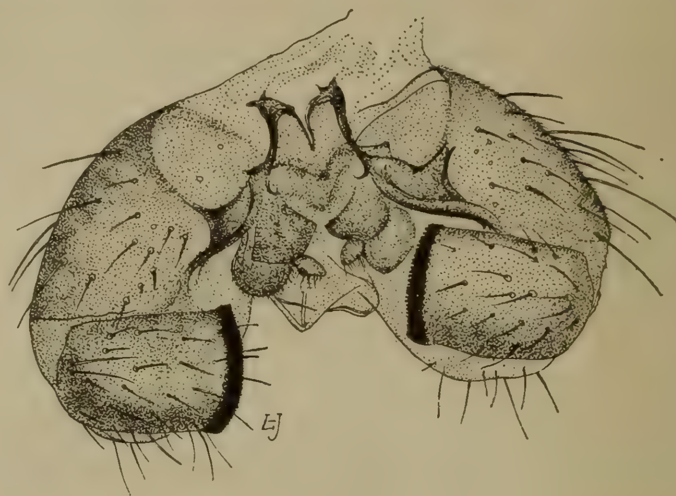
1908 ———— N. Y. State Mus. Bul. 124:380

This species was first taken at Albany, N. Y., May 18, 1906. It probably occurs on oak.

Male. Length 1.25 mm. Antennae extending to the third abdominal segment, naked, dark brown; 14 segments, the fifth with a length two and one-half times its diameter, 12 to 15 circumfili on each segment; terminal segment a little shorter than the preceding, broadly rounded. Palpi; the first segment short, stout, the second subquadrate, slightly expanded distally, the third rather stout, twice the length of the second, the fourth one-half longer than the third, slightly fusiform; eyes black. Mesonotum very dark brown,

submedian lines ornamented with setae. Scutellum and postscutellum reddish brown, the former with apical setae. Abdomen dark brown, rather sparsely clothed with yellowish setae. Wings

a



b

Fig. 30 Cincticornia transversa, male. *a*, sixth antennal segment; *b*, genitalia, enlarged (original)

hyaline, costa reddish brown. Halteres yellowish transparent. Legs yellowish red, tibiae and basal tarsal segments slightly lighter apically, the distal tarsal segments darker; claws stout, strongly curved. Genitalia; basal clasp segment short, stout, obliquely truncate; at the basal angle a conspicuous chitinous process is continued anteriorly and ventrally, uniting basally with its fellow on the opposite side and forming a pair of heavy, curved beaks; terminal clasp segment very short, stout. Dorsal plate short, rather deeply emarginate, the lobes angularly rounded. Type Cecid. 53.

Cincticornia serrata Felt

1908 **Felt, E. P.** N. Y. State Mus. Bul. 124:380

This species was reared in June 1908 from circular blister galls on scarlet oak, Quercus coccinea, taken near Boston, Mass., by Miss Cora H. Clarke.

Gall. The dark brown, broadly yellow-margined blister gall is circular and about 3 mm in diameter. The galls occur here and there upon the leaf.

Larva. Length 2 mm, yellowish orange, rather stout. Head very small; antennae short, stout. Breastbone slender, slightly expanded apically, bidentate. Skin coarsely shagreened, posterior extremity broadly rounded and with a pair of obtuse, semitransparent submedian tubercles.

Male. Length 2 mm. Antennae extending to the fourth abdominal segment, sparsely haired, dark brown; 14 segments, the fifth with a length about four times its diameter, about eight low circumfili. Palpi; the first segment short, stout, subquadrate, the second with a length about three times its diameter, narrowly oval, the third a little longer, more slender, irregular, the fourth a little longer and more slender than the third. Mesonotum dark reddish brown, the submedian lines sparsely haired. Scutellum and postscutellum fuscous yellowish. Abdomen sparsely haired, dark brown, the membrane and pleurae pale orange; genitalia fuscous. Wings hyaline, costa dark brown; halteres yellowish. Legs mostly dark brown; claws long, stout, strongly curved, simple, the pulvilli about two-thirds the length of the claws. Genitalia; dorsal plate short, broad, deeply and triangularly incised, the lobes short and roundly tapering. Type Cecid. a1791.

Cincticornia caryae Felt

1908 **Felt, E. P.** N. Y. State Mus. Bul. 124:380
1909 ———— Ent. Soc. Ont., 39th Rep't, p. 45

This species was erected for a male which the late Dr M. T. Thompson supposed he had reared from a conic leaf gall on hickory, the latter being considered identical with that of Cecidomyia sanguinolenta O. S. It is very probable that this is an error, since all species of Cincticornia known to us have been obtained from oak galls.

Male. Length 3 mm. Antennae extending to the third abdominal segment, sparsely haired, pale yellowish; 13 segments, the fifth with a length twice its diameter; 10 low anastomosing circumfili; terminal segment produced, slightly expanded and with an apical knob. Palpi; the first segment with a length twice its diameter, the second broadly oval, the third a little longer than the second, slender, the fourth one-half longer than the third. Face fuscous yellowish. Mesonotum probably fuscous brown, the scutellum and postscutellum presumably yellowish or yellowish orange, the abdomen probably reddish brown. Genitalia fuscous. Wings hyaline, costa light brown. Halteres probably pale yellowish. Legs yellowish brown; claws long, stout, strongly curved, the pulvilli a little shorter than the claws. Genitalia; dorsal plate short, broad, broadly and triangularly emarginate. Type Cecid. 1114.

Cincticornia quercifolia Felt

1908 **Felt, E. P.** N. Y. State Mus. Bul. 124:380

This was reared in the bureau of entomology from a flat gall on red oak, Quercus rubra, leaves collected in the District of Columbia, adults appearing April 1 to 27, 1896.

Male. Length 1.5 mm. Antennae probably extending to the third abdominal segment, sparsely haired, pale yellowish; 14 segments, the fifth with a length twice its diameter; 12 to 14 anastomosing circumfili; terminal segment produced, narrowly rounded. Palpi; the first segment short, subquadrate, the second about thrice the length of the first, the third one-half longer than the second, more slender, the fourth nearly twice the length of the third, dilated. Mesonotum reddish brown, the submedian lines thickly haired. Scutellum pale yellowish, postscutellum darker. Abdomen dark reddish brown, the segments rather thickly margined posteriorly with silvery hairs. Wings hyaline, costa light brown. Halteres pale yellowish. Legs light reddish brown; claws long, slender, strongly curved, the pulvilli shorter than the claws. Genitalia; dorsal plate short, deeply and narrowly emarginate, the lobes irregularly rounded.

Female. Length 1.5 mm. Antennae probably extending to the third abdominal segment, sparsely haired, light brown; 14 segments, the fifth with a length twice its diameter and 6 circumfili; terminal segment produced, narrowly rounded. Palpi; the first segment short, stout, subquadrate, the second more than twice the length of the first, more slender, the third one-half longer than the second, more slender, the fourth one-half longer than the third. Ovipositor about one-fourth the length of the abdomen, otherwise nearly as in the male. Type Cecid. 1043.

Cincticornia pustulata Felt

1909 **Felt, E. P.** Econ. Ent. Jour., 2:291

This species was reared in some numbers the latter part of April and early in May 1909 from oval, pustulate swellings on the leaves of the yellow barked or black oak, Quercus velutina, taken by Miss Cora H. Clarke at Magnolia, Mass., in October 1908. Apparently the same species was reared March 30, 1896 by Theodore Pergande from a similar leaf gall on red oak, Quercus rubra, taken at Washington, D. C.

Gall. This is a variable brown, irregularly oval, pustulate swelling 5 to 6 mm in diameter. It occurs here and there on the leaf surface.

Larva. Length 2 mm, semitransparent. Head small; antennae short, stout. Breastbone broadly bidentate, rather strongly chitinized anteriorly, weakly so posteriorly. Skin nearly smooth, strongly folded, posterior extremity broadly rounded and with a pair of short, broad tubercles.

Male. Length 2 mm. Antennae nearly as long as the body, sparsely haired, fuscous yellowish; 14 segments, the fifth with a length about three times its diameter; 8 or 9 circumfili; terminal segment slightly produced, with a length four times its diameter, apically a short, obtuse knob. Palpi; first segment short, rectangular, the second slender, with a length four times its diameter, the third as

long as the second, the fourth one-half longer than the third, all slender. Mesonotum dark brown, the submedian lines sparsely haired. Scutellum fuscous reddish, postscutellum fuscous orange. Abdomen sparsely haired, deep reddish orange, the small dorsal sclerites dark brown; genitalia fuscous. Wings short, broad, hyaline, costa fuscous. Halteres yellowish basally, fuscous yellowish apically. Coxae slaty brown; femora, tibiae and tarsi fuscous yellowish, the distal tarsal segments darker; claws slender, strongly curved, the pulvilli shorter than the claws. Genitalia; dorsal plate short, narrowly and deeply emarginate, the lobes broadly rounded.

Female. Length 2 mm. Antennae extending to the fourth abdominal segment, sparsely haired, fuscous yellowish, yellowish basally; 14 segments, the fifth with a length four times its diameter; the circumfili four, coarsely and irregularly reticulate; terminal segment slightly produced, an obtuse knob. Palpi; first segment short, subquadrate, the second with a length four times its diameter, the third a little longer, more slender, the fourth one-third longer than the second, slightly dilated. Mesonotum dark brown, the submedian lines thickly haired. Scutellum reddish brown, postscutellum fuscous. Abdomen sparsely haired, the rather small dorsal sclerites dark brown, the incisures and pleurae deep reddish orange. Coxae fuscous yellowish; femora and tibiae a variable fuscous yellowish and dark brown, tarsi mostly dark brown or black. Ovipositor about half the length of the abdomen. Type Cecid. a1789.

Cincticornia simpla Felt

1909 **Felt, E. P.** Econ. Ent. Jour., 2:291

The oval blister galls on oak produced by this species are so insignificant as rarely to attract the attention of any but those specially interested in the study of insect galls. This species was reared in small numbers from several lots of galls taken by Miss Cora H. Clarke on yellow barked oak, Quercus velutina, at Magnolia, Mass., and also from blister swellings on the leaves of red oak, Quercus rubra, taken in the vicinity of Albany, N. Y.

Gall. An irregularly oval pustulate swelling 5 to 6 mm in diameter and showing equally on both surfaces but with no distinct nipple. The galls are a variable brown in the fall, darker than the normal tissue and occur here and there on the leaf. Apparently the same species produces a slightly green or variable yellowish and red elevation on both surfaces of the leaf some 5 by 7 mm in diameter. Several larvae occur in the cavity beneath.

Larva. Length 3 mm, whitish or yellowish, rather stout. Head small; antennae short, stout. Breastbone well developed, bidentate, the teeth rather long, stout; shaft well developed; segmentation

distinct. Skin finely shagreened, the posterior extremity narrowly rounded.

Male. Length 2 mm. Antennae extending to the fifth abdominal segment, sparsely haired, fuscous yellowish; 14 subsessile, cylindric

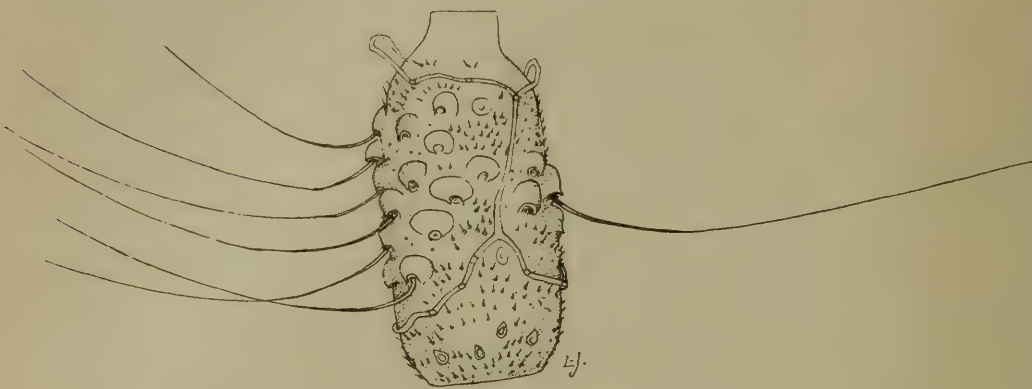


Fig. 31 Cincticornia simpla. Fifth antennal segment of male, enlarged (original)

segments, the fifth with a stem one-fourth the length of the cylindric basal enlargement, which latter has a length two and one-half times its diameter, the subapical whorl thick and long; low, irregular circumfili occur near the basal third and apically; terminal segment produced, with a length four times its diameter, tapering distally. Palpi; the first segment with a length three times its diameter, in-

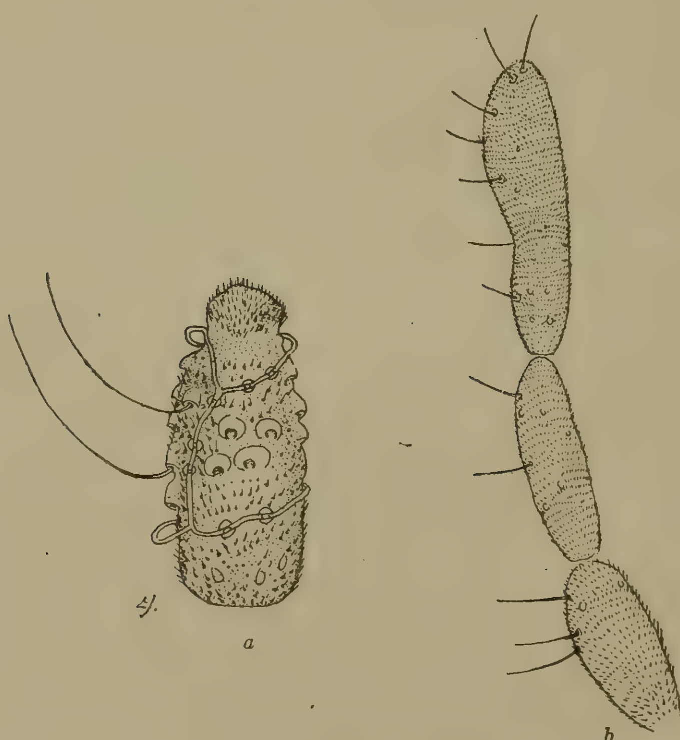


Fig. 32 Cincticornis simpla, male. *a*, terminal antennal segment; *b*, palpus, enlarged (original)

crassate, the second narrowly lanceolate, one-half longer; the third a little longer than the second, slender, the fourth a little longer than the third. Mesonotum dark brown, the submedian lines thickly haired. Scutellum reddish brown, postscutellum fuscous yellowish. Abdomen dark brown, the incisures and pleurae yellowish red, the segments sparsely haired posteriorly; genitalia fuscous. Wings hyaline, costa dark brown. Halteres yellowish basally, pale orange apically, fuscous subapically. Coxae fuscous yellowish; femora and tibiae mostly fuscous yellowish; tarsi dark brown; claws long, rather stout, strongly curved, the pulvilli shorter than the claws. Genitalia; dorsal plate short, broad, deeply and narrowly emarginate, the lobes broadly rounded.

Female. Length 2 mm. Antennae extending to the fourth abdominal segment, sparsely haired, fuscous yellowish, yellowish basally; 14 segments, the fifth with a length three and one-half times its diameter; subapically a few scattering setae; irregular, high, unusually thick, irregularly anastomosing circumfili near the basal third and apically (figure 33); terminal segment somewhat reduced,

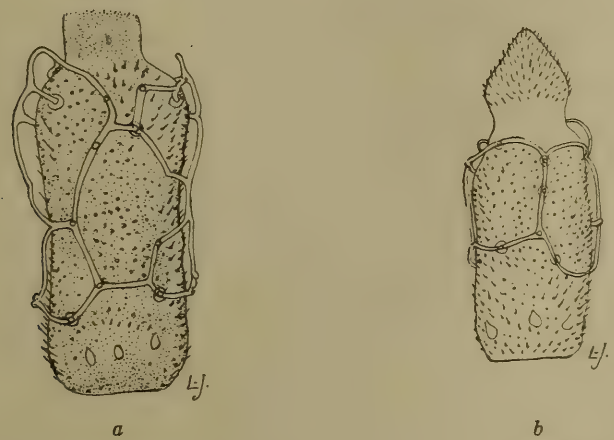


Fig. 33 Cincticornia simpla. Fifth (*a*) and distal (*b* antennal segments of female, enlarged (original)

with a length three times its diameter, the apical fourth constricted, narrowly rounded; claws stout, irregularly curved, the pulvilli shorter than the claws. Ovipositor about two-thirds the length of the abdomen. Otherwise nearly as in the male. Type Cecid. a1789d, a1942, a1947.

Cincticornia podagrae Felt

1909 **Felt, E. P.** Econ. Ent. Jour., 2:291

This species was reared in small numbers in April 1908 from a narrow, fusiform vein swelling on the leaves of the yellow-barked or black oak, Quercus velutina, collected by Miss Cora H. Clarke at Magnolia, Mass., in October 1908.

Gall. This is a narrow, dark purplish, fusiform, thin-walled swelling some 8 mm long on the under side of the mid or lateral veins and may contain two or more orange larvae.

Larva. Length 1.5 mm, rather slender, tapering at both extremities, orange color. Head rather small; antennae stout. Breastbone expanded apically and obtusely dentate. Skin coarsely shagreened, posterior extremity broadly rounded and with submedian obtuse tubercles.

Male. Length 2 mm. Antennae extending to the fourth abdominal segment, sparsely haired, dark brown, yellowish basally; 14 segments, the fifth with a length nearly four times its diameter; 7 or 8 anastomosing circumfili; terminal segment produced, with a length about five times its diameter and a rather long, obtuse knob. Palpi; first segment short, stout, second with a length fully three times its width, the third as long as the second, the fourth one-half longer, somewhat dilated. Mesonotum slaty brown, the submedian lines thickly haired. Scutellum dark brown, postscutellum fuscous. Abdomen a variable reddish or dark brown, the segments sparsely haired, the incisures and pleurae deep red. Wings short, broad, costa dark brown. Halteres pale orange, fuscous subapically. Coxae and legs mostly dark brown; claws rather slender, strongly curved, the pulvilli shorter than the claws. Genitalia; dorsal plate short, divided, the lobes broad, truncate.

Female. Length 2.5 mm. Antennae extending to the third abdominal segment, sparsely haired, dark brown; 14 segments, the fifth with a length four times its diameter; about four circumfili form coarse recticulations; terminal segment slightly reduced, with a length three and one-half times its diameter, tapering, subacute. Scutellum yellowish red, postscutellum darker. Abdomen sparsely haired, mostly dark brown, the incisures and pleurae deep orange; ovipositor pale yellowish. Coxae fuscous yellowish, the femora darker, the tibiae and tarsi mostly dark brown. Ovipositor about two-thirds the length of the abdomen. Otherwise nearly as in the male. Type Cecid. a1788.

Cincticornia globosa Felt

1909 **Felt, E. P.** Econ. Ent. Jour., 2:291

This dark-brown species with short, relatively broad wings was reared in some numbers from a subhemispheric, brown, slightly nippled, oak leaf gall on black oak, probably Quercus velutina, in April and May 1909 from material collected by Miss Cora H. Clarke at Magnolia, Mass., in October 1908. Apparently the same gall was taken by Miss Clarke on the scarlet oak, Quercus coccinea. A very similar oak leaf gall may produce a Cynipid.

Gall. Subhemispheric, brown, slightly nippled, 1.75 mm in diameter. It is monothalamous, occurs on the under side of the leaf and causes on its upper surface a slight, brownish elevation encircled by yellowish orange.

Larva. Length 2.25 mm, rather stout, bright lemon yellow. Head small; antennae short, stout. Breastbone broadly and irregularly bidentate, the shaft narrow. Skin coarsely shagreened, posterior extremity broadly rounded with submedian obtuse tubercles and numerous short, stout, semitransparent spines.

Male. Length 2 mm. Antennae extending to the fifth abdominal segment, sparsely haired, fuscous yellowish; 14 segments, the fifth with a length about three times its diameter; about 11 low circumfili; terminal segment produced, with a length five times its diameter, tapering. Palpi; first segment presumably stout, the second with a length four times its diameter, the third a little longer, more slender, the fourth one-half longer than the third. Mesonotum dark brown, the submedian lines thickly haired. Scutellum reddish brown, postscutellum fuscous yellowish. Abdomen dark brown, the incisures and pleurae yellowish red, the segments sparsely haired posteriorly; genitalia fuscous. Wings hyaline, costa dark brown; halteres yellowish basally, pale orange apically, fuscous subapically. Coxae fuscous yellowish; femora and tibiae mostly fuscous yellowish; tarsi dark brown; claws long, slender, strongly curved, pulvilli shorter than the claws. Genitalia; dorsal plate short, deeply and roundly emarginate, the lobes broadly rounded.

Female. Length 2 mm. Antennae extending to the fourth abdominal segment, sparsely haired, fuscous yellowish; 14 segments, the fifth with a length fully four times its diameter, with four coarsely anastomosing circumfili; terminal segment slightly reduced, tapering, narrowly rounded. Palpi; first segment subquadrate, the second one-half longer, slender, the third a little longer, more slender than the second, the fourth one-half longer than the third. Scutellum deep red, postscutellum fuscous. Abdomen reddish orange, the rather small dorsal sclerites dark brown and sparsely margined with yellowish hairs. Halteres yellowish basally, fuscous apically. Coxae slaty brown. Ovipositor about two-thirds the length of the abdomen. Type Cecid. a1902.

Cincticornia americana Felt

1908 **Felt, E. P.** N. Y. State Mus. Bul. 124:380, 381

This small, broad-winged form was reared in April 1908 from a slight blisterlike swelling on the lateral veins of red oak, Quercus rubra taken at Albany, N. Y., November 12, 1907.

Gall. The gall is a slight, circular, blisterlike swelling on the lateral veins beneath and of very nearly the same color as the leaf.

It is some 3 mm long and 1 mm wide, and may extend along the vein as well as into the leaf tissues beside.

Larva. Length 2.5 mm, orange, rather stout, the head rather broad, the antennae short, stout. Breastbone slightly expanded anteriorly, bidentate, obsolescent posteriorly. Skin nearly smooth, posterior extremity broadly rounded, with a pair of broad submedian tubercles.

Male. Length 2.5 mm. Antennae nearly as long as the body, sparsely haired, fuscous yellowish; 14 segments, the fifth with a length about three times its diameter; circumfili 7, forming fine reticulations; terminal segment produced, with a length four times its diameter, tapering, narrowly rounded. Palpi; first segment short, stout, the second with a length over three times its diameter, rather stout, the third a little longer, more slender, the fourth one-half longer than the third, somewhat dilated. Face pale yellowish. Mesonotum fuscous yellowish, the submedian lines thickly haired. Scutellum pale yellowish, postscutellum yellowish. Abdomen sparsely haired, mostly yellowish orange, the small dorsal and ventral sclerites fuscous; genitalia fuscous. Wings small, narrow, costa fuscous. Halteres light fuscous yellowish, fuscous subapically. Coxae and femora light fuscous yellowish, the tibiae slightly darker; tarsi mostly dark brown; claws rather stout, strongly curved, the pulvilli shorter than the claws. Genitalia; dorsal plate short, divided, the lobes narrowly rounded.

Female. Length 2 mm. Antennae extending to the third abdominal segment, sparsely haired, fuscous yellowish; 14 segments, the fifth with a length three and one-half times its diameter; four circumfili form coarse reticulations; terminal segment slightly reduced, with a length three times its diameter, narrowly rounded. Mesonotum shining dark brown, the submedian lines sparsely haired. Scutellum dark reddish, postscutellum fuscous yellowish. Abdomen sparsely haired, the sclerites shining dark brown, membrane and pleurae deep orange; ovipositor yellowish, when extended about two thirds the length of the abdomen. Otherwise nearly as in the male. Type Cecid. a1792.

Cincticornia multifila Felt

1907 **Felt, E. P.** N. Y. State Mus. Bul. 110:118–19 (separate p. 22) (Asphondylia)
1908 ———— N. Y. State Mus. Bul. 124:380

This species appears to be a rather common form under certain conditions in the vicinity of Albany, N. Y., since it was taken June 1, 1906 while sweeping white oak Quercus alba.

Male. Length 1.25 mm. Antennae extending to the base of the abdomen, sparsely haired, light brown; 13 segments, the fifth with a length two and one-half times its diameter and six or seven circumfili; terminal segment produced and composed of two closely

.sed segments. Palpi; the first segment suboval, the second one-ourth longer than the first, the third about one-third longer than the second, the fourth one-third longer than the third, each more slender than the preceding. Mesonotum dark brown. Scutellum reddish brown, postscutellum a little lighter. Abdomen nearly uniform dark brown. Wings hyaline, costa reddish. Halteres yellowish transparent. Legs pale yellowish brown, tarsi a little darker; claws stout, uniformly curved. Genitalia; dorsal plate broad, deeply and roundly emarginate, the lobes acutely rounded. Type Cecid. 95, 99, 100.

Cincticornia rhoina Felt

1907 **Felt, E. P.** N. Y. State Mus. Bul. 110:123 (separate p. 26), (Oligotrophus)
1908 ——— N. Y. State Mus. Bul. 124:381

This species was taken at Albany, N. Y., June 1, 1906 while sweeping sumac, Rhus.

Male. Length .75 mm. Antennae a little longer than the body, sparsely haired, light brown; 13 segments, the fifth with a length two and one-half times its diameter and five or six circumfili; the thirteenth and fourteenth segments closely fused. Palpi; first segment subquadrate, the second one-half longer than the first, the third longer than the second and the fourth one-half longer than the third. Mesonotum dark brown. Scutellum light brown with sparse apical setae, postscutellum yellowish brown. Abdomen a somewhat variable yellowish brown, the anterior four segments irregularly marked near the median line with dark brown. Wings hyaline, costa reddish brown. Halteres yellowish transparent. Legs pale yellowish brown, tarsi darker; claws stout, rather strongly curved, the pulvilli shorter than the claws. Genitalia; dorsal plate broad, tapering, deeply and triangularly emarginate. Type Cecid. 94.

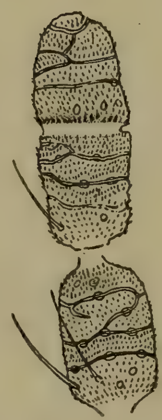


Fig. 34 Cincticornia rhoina, male, distal antennal segments, enlarged (original)

Cincticornia cornifolia Felt

1907 **Felt, E. P.** N. Y. State Mus. Bul. 110:124 (separate p. 28), (Oligotrophus)

This yellowish species was taken on flowering dogwood, Cornus florida, at Albany, N. Y., May 18, 1906.

Female. Length 1.25 mm. Antennae extending to the third abdominal segment, reddish brown, sparsely haired; 13 segments,

the fifth with a length two and one-half times its diameter; subbasal whorl scattering, subapical whorl rudimentary; indistinct circumfili near the basal third and apically and with a variable anastomosis between; terminal segment with a length four times its diameter, evidently composed of two. Palpi; first segment short, stout, the second rectangular, with a length nearly four times its diameter, the third a little longer, more slender, the fourth longer and more slender than the third. Mesonotum dark brown, the submedian lines and the median posterior area yellowish. Scutellum yellowish red with numerous yellowish apical setae, postscutellum yellowish. Abdomen yellowish with the basal segments tinged with red, the first slightly darker. Wings hyaline, costa reddish brown. Halteres and coxae yellowish transparent; femora and tibiae yellowish tinged with red, tarsi somewhat darker; claws slender, evenly curved, the pulvilli shorter than the claws. Ovipositor about two-thirds the length of the abdomen. Type Cecid. 49c.

Cincticornia pilulae Walsh

1864 **Walsh, B. D.** Ent. Soc. Phil. Proc., 2:481–82 (Cecidomyia q. pilulae)
1869 ———— Am. Ent., 2:29 (Cecidomyia)
1890 **Packard, A. S.** U. S. Ent. Com. 5th Rep't, p. 206–7 (Cecidomyia)
1892 **Beutenmueller, William.** Am. Mus. Nat. Hist. Bul. 4:269 (Cecidomyia)
1894 ———— Am. Mus. Nat. Hist., Guide Leaflet 16, p. 30 (Cecidomyia)
1902 **Cook, M. T.** Ohio State Univ. Bul. 15, ser. 6, p. 267 (Cecidomyia)
1905 ———— Dep't Geol. & Nat. Res. Ind., 29th Rep't, p. 841 (Cecidomyia)
1906 **Felt, E. P.** Ins. Affec. Pk. & Wdld. Trees, N. Y. State Mus. Mem. 8, 2:619, 627 (Cecidomyia)
1908 ———— N. Y. State Mus. Bul. 124:380, 381
1909 ———— Ent. Soc. Ont., 39th Rep't, p. 45
1910 **Stebbins, F. A.** Springf. Mus. Nat. Hist. Bul. 2, p. 18

This species appears to be one of the commonest representatives of the genus. The gall is by no means rare on various species of oak in the vicinity of Albany and in other parts of the country. It is presumable that all of the citations given above relate to this form, though we have reared Cynipids from galls supposed to be made by Cincticornia on several occasions. It would not be surprising if the work of two very dissimilar insects had been confounded occasionally. The late Dr M. T. Thompson of Clark University records the appearance of the young gall at Worcester, Mass., the second week in June, while Professor Beutenmueller states that in the vicinity of New York City it begins to develop in May and becomes full size by August or September. At first it is blister-like, yellow or pale brown and surrounded by a light-green ring. The full-grown gall varies greatly in size, ranging from about 3 to

6 or 7 mm in diameter and presents a characteristic reticulated appearance. The insect winters in the gall, the larvae escape and form silk-lined cells among leaves or in the soil prior to transformation. The late Doctor Thompson records having taken this gall on Quercus ilicifolia, Q. rubra, Q. coccinea, Q. stellata and Q. palustris. It also occurs on Q. falcata, Q. velutina and Q. nigra. Professor Beutenmueller states that it is found on various species belonging to the red oak group. Galls of this species were received from Riverdale, Md. through Dr W. L. McAtee accompanied by the statement that flocks of sparrows were observed opening the galls and eating the larvae.

There is in the Museum of Comparative Zoology at Cambridge, Mass., a gall labeled Cecidomyia palustris O. S. The deformity described by him (Ent. Soc. Phil. Proc., 1:252 and 4:359) is most probably the work of a Cincticornia and may be only a modified form of C. pilulae Walsh.

The adult of what may have been this species was briefly characterized by Dr A. S. Packard in the 5th Report of the U. S. Entomological Commission. The characters given are insufficient for the recognition of the species and it is possible that Doctor Packard was misled and characterized an inquiline or some form issuing from other material. We were fortunate in rearing a large series of adults in the spring of 1909. Midges of this species were obtained in numbers by the late Dr M. T. Thompson of Worcester, Mass., from material collected in that vicinity. It was taken by Prof. C. W. Johnson May 19, 1901 at Clementon, N. J., April 26, 1896 in Delaware county, Pa., and was reared from galls on Quercus nigra and Q. rubra taken at Washington, D. C., in March and April 1896 by the bureau of entomology. These specimens, while presenting some minor variations among themselves, are probably all referable to one species. This midge appears to be widely distributed, having been recorded, in addition to the localities given above, from Mississippi, Indiana, Illinois and Rhode Island.

Gall. Reddish brown, coarsely reticulate, thick walled, irregularly subglobose, 3 to 4 mm in diameter, somewhat depressed or fused to form lobulate masses 1 cm or more in length. The galls may occur scatteringly on the leaves or be present in large numbers, there being from 1 to 4 or 5 up to possibly 75 on a leaf. On badly infested leaves the galls may be confluent, and occasionally a considerable number adhere to form an almost continuous mass on

one or both sides of the midvein. The young galls are fleshy while the old ones are very hard and woody. Normally but one larva occurs in the typical gall, though three or four are frequently present in a confluent mass.

Larva. Length 3 mm, rather stout, reddish orange; head slightly rounded, triangular, the posterior angles with long, chitinous processes. Antennae rather long, stout, biarticulate, the terminal segment minute. Breastbone expanded anteriorly, bidentate, the teeth widely separated, irregularly rounded, the shaft tapering and disappearing posteriorly; skin coarsely shagreened. Terminal segment small, rounded.

Fig. 35 Cincticornia pilulae. *a*, breastbone of larva; *b*, posterior extremity, enlarged (original)

Male. Length 3 mm. Antennae extending to the fourth abdominal segment, sparsely haired, fuscous yellowish, yellowish basally; 14 segments, the fifth with a length a little over twice its diameter, 9 circumfili; terminal segment somewhat prolonged, narrowly rounded. Palpi; the first segment short, stout, subquadrate, the second more than twice the length of the first, more slender, the third a little stouter and hardly as long as the second, the fourth nearly twice the length of the third, strongly flattened and somewhat dilated. Mesonotum a dark brown, the submedian lines sparsely haired. Scutellum fuscous yellowish, postscutellum a little darker. Abdomen dark brown, the incisures and pleurae pale salmon, ventral sclerites dark brown. Wings hyaline, costa light brown; halteres whitish transparent. Legs with the coxae and femora a deep fuscous yellowish, the tarsi lighter; claws long, slender, evenly curved, the pulvilli shorter than the claws.

Female. Length 3.5 mm. Antennae extending to the fourth abdominal segment, sparsely haired, dark brown, the basal segments fuscous yellowish; 14 segments, the fifth with a length two and one-half times its diameter, with four circumfili; terminal segment with a length one-half greater than its diameter, irregularly rounded. Palpi; the first segment stout, with a length about twice its diameter, the second one-half longer, more slender, the third a little longer and more slender than the second and the fourth about one-half longer than the third, strongly flattened and dilated. Mesonotum dark brown, the submedian lines indistinct. Scutellum a reddish yellow, postscutellum yellowish anteriorly, fuscous posteriorly. Abdomen with the dorsal and ventral sclerites dark red, the incisures and pleurae dull red, the ovipositor pale yellowish. Wings hyaline, costa light brown; halteres pale yellowish basally, whitish apically, fuscous subapically. Legs fuscous yellowish; claws long, slender, strongly curved, simple, the pulvilli shorter than the claws. Ovipositor short. Cecid. 1105.

Cincticornia symmetrica O. S.

1862 **Osten Sacken R.** Mon. Dipt. N. A., 1:200–1 (Cecidomyia)

1869 **Walsh, B. D. & Riley, C. V.** Am. Ent., 2:29 (Cecidomyia)

1891 **Riley, C. V. & Howard, L. O.** Ins. Life, 4:126 (Polygnotus tumidus Ashm. reared, Cecidomyia)

1892 **Beutenmueller, William.** Am. Mus. Nat. Hist. Bul. 4:270 (Cecidomyia)

1906 **Felt, E. P.** Ins. Affec. Pk. & Wdld. Trees, N. Y. State Mus. Mem. 8, 2:710 (Cecidomyia)

1910 **Stebbins, F. A.** Springf. Mus. Nat. Hist. Bul. 2, p. 18 (Cecidomyia)

This deformity has been described by Osten Sacken as a hard, red gall on the leaves of different kinds of oak. It is small and round, between one-twentieth and one-tenth of an inch in diameter, though more commonly assuming an irregular shape by the coalescence of several galls. He states that this gall occurs in large numbers on the leaves of Quercus falcata in autumn, sometimes occupying almost the entire leaf and having exactly the same size and shape on both surfaces. A study of the types of this gall in the Museum of Comparative Zoology at Cambridge, showed that it was very close to, if not identical with, that of Cincticornia pilulae. Beutenmueller states that it differs from the more common C. pilulae by protruding equally on both surfaces of the leaf, and adds that it has not been found in the vicinity of New York City. The larvae in the collections of the United States National Museum and labeled as having come from this gall, belong to the genus Cincticornia and possibly may be different from those of C. pilulae. It is provisionally placed next this common species.

Cincticornia canadensis Felt

1908 **Felt, E. P.** N. Y. State Mus. Bul. 124:380

This species, taken at Toronto, Ont., bears the date label 3–5–91 and occurs in the National Museum collection.

Female. Length 2 mm. Antennae extending to the fourth abdominal segment, sparsely haired, dark brown; 14 segments, the fifth with a length two and one-half times its diameter, and with 6 circumfili; terminal segment slightly reduced, tapering to a narrowly rounded apex. Palpi; the first segment short, stout, rounded distally, the second about twice the length of the first, rather stout, the third a little shorter than the second and the fourth about twice the length of the third. Mesonotum dark brown. Scutellum purplish brown, postscutellum reddish brown. Abdomen dark reddish brown. Wings hyaline, costa light brown. Halteres fuscous yellowish basally, pale salmon apically. Legs mostly pale yellowish brown; claws rather long, moderately stout, strongly curved, the pulvilli shorter than the claws. Ovipositor about one-half the length of the abdomen. Type Cecid. 1042.

Cincticornia sobrina Felt

1907 **Felt, E. P.** N. Y. State Mus. Bul. 110:158 (Asphondylia)
1908 ———— N. Y. State Mus. Bul. 124:381

Adults of this form were first reared by the late Dr M. T. Thompson of Clark University, Worcester, Mass., from a vial containing earth brought into the laboratory for the purpose of rearing Tineids. It was then thought that they might have come from some seed, possibly elm keys. Subsequent rearings in April 1911 resulted in obtaining numerous flies, referable with little question to this species, from the leaves of the black oak, Quercus velutina, and probably those of other species, thickly infested with an inconspicuous, circular, blister gall. This species may be most easily distinguished from allied forms by the coarse reticulations formed by the circumfili on the antennal segments of both male and female, there being four or five transverse fili on each.

Gall. An inconspicuous, circular, blister enlargement showing mostly on the under surface of the leaf and varying in diameter from 3 to 5 mm.

Larva. Length 3.5 mm, stout, probably yellowish orange. Head rather long, narrow, tapering. Antennae short, subconic, biarticulate; breastbone long; the shaft rather stout, with a uniform diameter, pale basally, expanded apically and minutely bidentate; skin coarsely shagreened; posterior extremity broadly rounded and apically with submedian short, conical, chitinous processes.

Exuviae. Male. Length 4 mm, stout, pale yellowish white, the wing cases extending to the third, the leg cases to the fourth, and the antennal sheaths to the fifth abdominal segment. The dorsum of each of the abdominal segments is rather thickly covered with long,

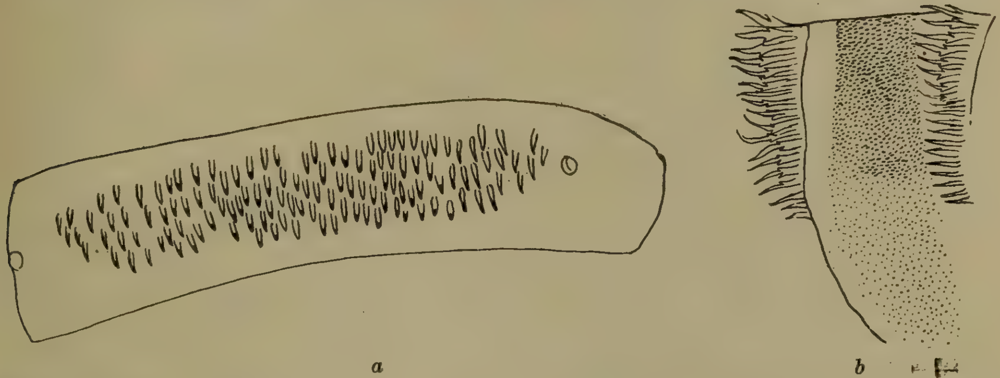


Fig. 36 Cincticornia sobrina. *a*, dorsal aspect of the third abdominal segment of the pupa; *b*, lateral view of the same, enlarged (original)

heavily chitinized triangular spines (figure 36), the entire surface being uniformly dotted with the same. Terminal segment broadly rounded, with a roundly triangular area bounded by an irregular chitinous thickening, the posterior lateral angles marked by conspicuous rounded chitinous processes.

Female. Length 3 mm, stout, pale yellowish, the thoracic horns long, slender, curved, the wing cases extending to the third abdominal segment, the leg cases to the fourth, the dorsum of the abdominal segments with a treble row of short, stout, heavily chitinized spines on the basal third, the row on the last segment being double, the posterior two-thirds of the abdominal segment with the surface thickly dotted with minute triangular points.

The exuviae differs markedly from those of Asphondylia in the peculiar ornamentation on the dorsum of the abdominal segments. There is also a marked sexual difference, the antennal sheath of the male having about sixty distinct annulations, approximately one to each circumfilum. The dorsum of the abdominal segments in the male is entirely covered with the stout, chitinous spines observed in the opposite sex only on the basal third of the segments.

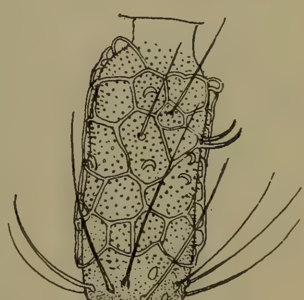


Fig. 37 Cincticornia sobrina. Fifth antennal segment of male, enlarged (original)

Male. Length 3 mm. Antennae extending to the second abdominal segment, sparsely haired, light yellowish; 14 segments, the fifth with a length two and one-half times the diameter, and 4 circumfili; terminal segment slightly reduced, tapering to an obtusely rounded apex. Palpi; the first segment irregularly subquadrate, swollen distally, the second one-half longer, subrectangular, the third

one-half longer than the second, tapering slightly at each extremity, the fourth nearly twice the length of the preceding, more compressed; face fuscous yellowish. Mesonotum dark brown, the submedian lines rather thickly clothed with yellowish hairs. Scutellum reddish yellow, postscutellum yellowish. Abdomen a reddish brown, the genitalia yellowish, fuscous distally. Wings hyaline, costa light brown; halteres semitransparent basally and apically, fuscous yellowish subapically. Legs a variable light fuscous yellowish, the tarsi somewhat darker; claws long, slender, strongly curved, the pulvilli a little shorter than the claws.

Female. Length 3.5 mm. Antennae extending to the second abdominal segment, sparsely haired, pale yellowish; 14 segments, the fifth with a length about two and one-half times its diameter and with four circumfili. Palpi; the first segment short, subquadrate, the second more than twice the length of the preceding, the third a little longer and more slender than the second, the fourth one-half longer than the third, strongly flattened and somewhat dilated apically; face yellowish. Mesonotum a light fuscous orange, the submedian lines lighter. Scutellum a pale yellow, postscutellum yellowish. Abdomen a pale orange, the distal segments lighter. Wings hyaline, costa light brown; halteres whitish transparent basally and apically, somewhat fuscous subapically. Legs a variable fuscous yellowish, the tarsi darker; claws long, slender, strongly curved, simple, the pulvilli a little shorter than the claws. Ovipositor short, less than one-half the length of the abdomen. Type Cecid. 1108.

Cincticornia connecta Felt

1908 **Felt, E. P.** N. Y. State Mus. Bul. 124:381

This species was taken at Westville, Conn., May 8, 1903, by Dr W. E. Britton, state entomologist. A supplementary label on the pin bears the statement: "Color of a red mite."

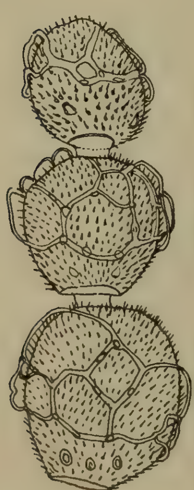


Fig. 38 Cincticornia connecta. Distal three antennal segments of female, enlarged (original)

Female. Length 3.5 mm. Antennae extending to the second abdominal segment, sparsely haired, fuscous yellowish; 14 segments, the fifth with a short stem and a length three and one-half times its diameter, two circumfili; terminal segment distinctly reduced, the twelfth with a length about one-half greater than its diameter, the thirteenth and fourteenth each irregularly subglobose. One antenna is peculiar in having 15 segments. Palpi; the first segment short, stout, narrowly oval, the second one-half longer, more slender, the third about as long as the second, more slender, the fourth one-half longer than the third, slightly dilated; face reddish yellow, eyes rather large, black. Mesonotum reddish brown, the submedian lines

rather broad, fuscous yellowish, slightly expanded at the anterior margin and continued along the lateral margin. Scutellum fuscous yellowish, postscutellum reddish brown. Abdomen rather thickly clothed with fuscous hairs, reddish yellow and in life probably deep red. Wings hyaline, costa light brown; halteres pale yellowish basally, fuscous apically. Coxae and femora fuscous yellowish,

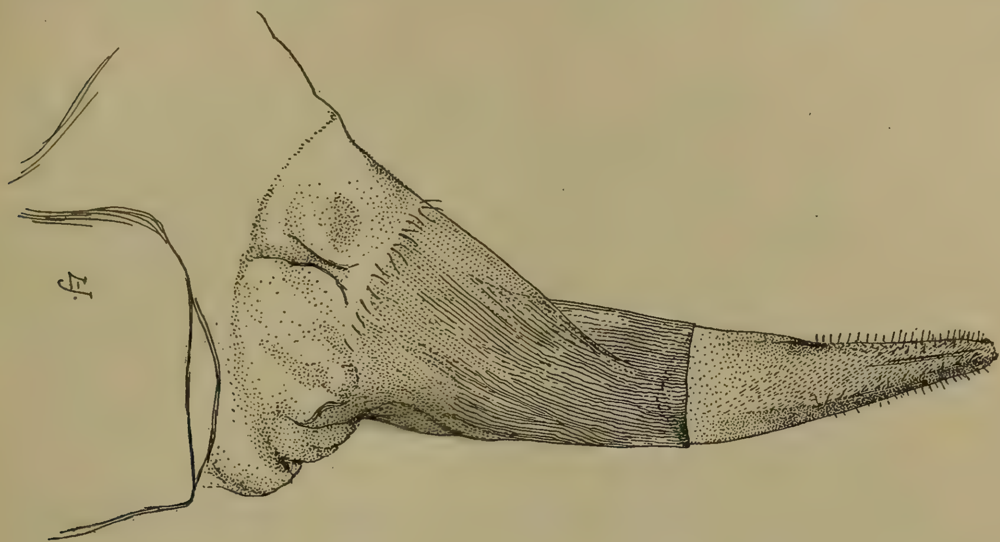


Fig. 39 Cincticornia connecta. Posterior extremity of female showing ovipositor extended, enlarged (original)

tibiae and tarsi mostly a very dark fuscous yellowish, owing to the presence of numerous long, black hairs; claws long, moderately stout, strongly curved, the pulvilli as long as the claws. Ovipositor about one-half the length of the abdomen. Type Cecid. 822.

Cincticornia pustuloides Beutm.

1907 **Beutenmueller, William.** Amer. Mus. Nat. Hist. Bul. 23:390 (Cecidomyia)
1910 **Stebbins, F. A.** Springf. Mus. Nat. Hist. Bul. 2:22, 24

This species is with very little question referable to Cincticornia. The gall is circular, blisterlike and protrudes slightly on each side of the leaf. It measures 4 to 7 mm in diameter and occurs in September in clusters on the leaves of various kinds of oaks.

FELTOMYIA Kieffer

1911 **Felt, E. P.** N. Y. Ent. Soc. Jour., 19:48–49 (Uleella)
1912 ———— Ent. News, 23:353–54 (Uleella)
1913 **Kieffer, J. J.** Gen. Insect., fasc. 152, p. 100
1915 **Felt, E. P.** U. S. Nat. Mus. Proc. 48:198

This tropical American genus was erected for a remarkably synthetic form, the generic type being F. pisonifolia Felt.

Antennal segments 14, cylindric, sessile, the distal one in the female reduced; the circumfili in the male are large and very irregular, the palpi triarticulate; the third vein unites with the margin at the apex of the wing; the terminal clasp segment of the male is subapical and serrate distally, while the ovipositor is short with feebly chitinized plates and a moderately stout, variably chitinized terminal portion.

The slight reduction of the terminal antennal segments in the female and the palps indicates relationship with Asphondylia, the terminal clasp segment of the male shows affinity with Cincticornia, while the circumfili are nearly identical with those of Schizomyia. Detailed description of adults, erroneously referred to Bruggmanniella, have been given by the writer in 1911 in the Journal of Economic Entomology, 4:547, and in 1912 in Entomological News, 23:174-75.

Feltomyia pisonifolia Felt

1912 **Felt, E. P.** Ent. News, 23:353-54 (Uleella)

This species was reared in June 1911 from oval leaf galls on Pisonia nigricans collected by Mr W. H. Patterson, St Vincent, W. I.

Feltomyia mexicana Felt

1911 **Felt, E. P.** Econ. Ent. Jour., 4:547 (Bruggmanniella)

This species was reared from an irregular stem gall on a plant provisionally identified as Pisonia aculeata Linn. and collected by E. A. Schwarz at Tampico, Mexico, December 1909.

Feltomyia pisoniae Felt

1912 **Felt, E. P.** Ent. News., 23:174-75 (Bruggmanniella)

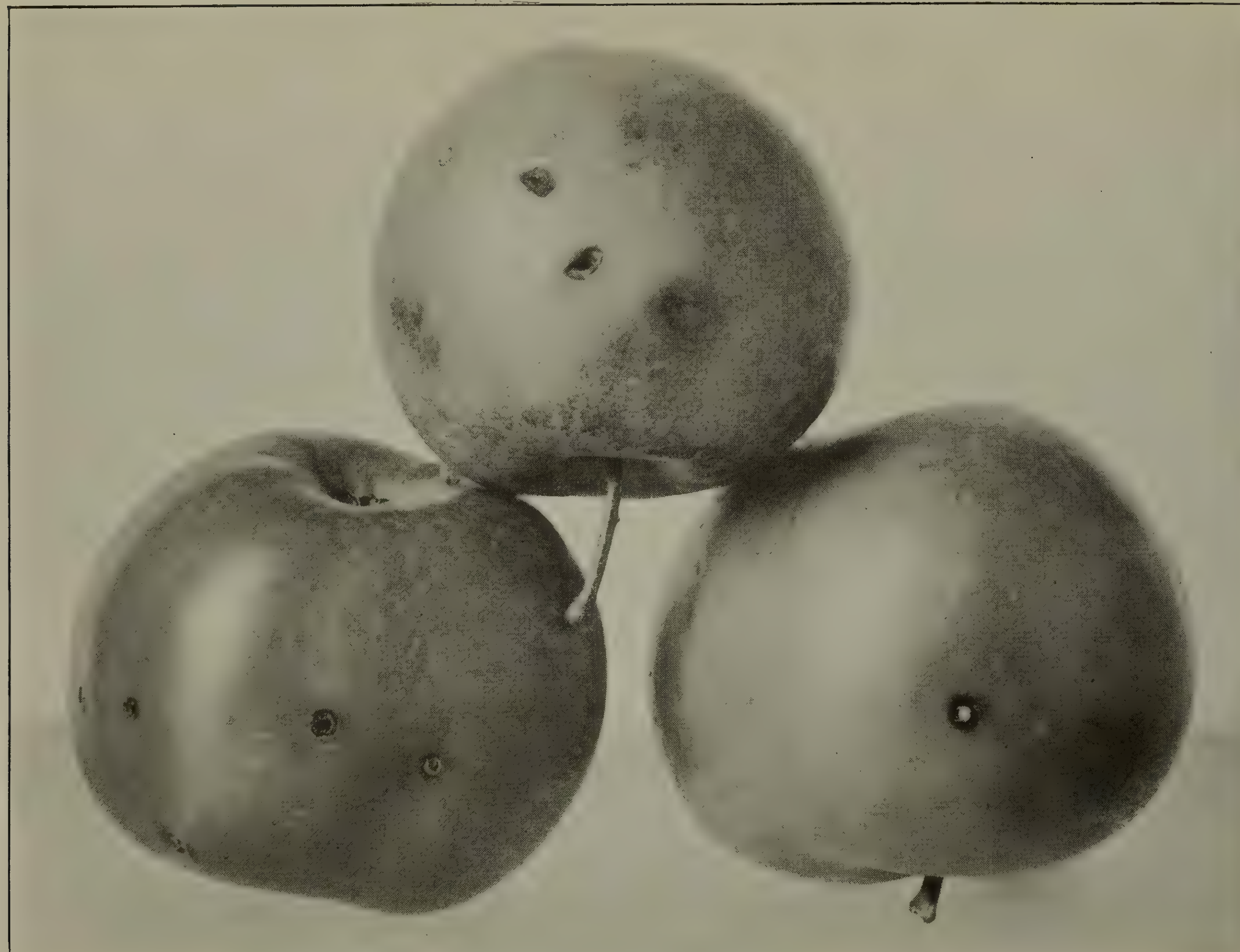
This midge was reared May 5, 1911 from irregular stem galls on Pisonia nigricans collected by Mr W. H. Patterson, St Vincent, W. I.

EXPLANATION OF PLATES

PLATE I

Codling moth, Carpocapsa pomonella Linn.
Three apples showing typical side injury

Plate 1



Side injury or "sting"

PLATE 2

Codling moth, C a r p o c a p s a p o m o n e l l a Linn.

Three apples showing one type of hail injury, simulating in appearance the side injury illustrated on plate 1

Plate 2

A type of hail injury resembling codling moth side injury

PLATE 3

Codling moth, C a r p o c a p s a   p o m o n e l l a Linn.

Typical side-wormy apples showing the work of nearly full-grown larvae

Plate 3

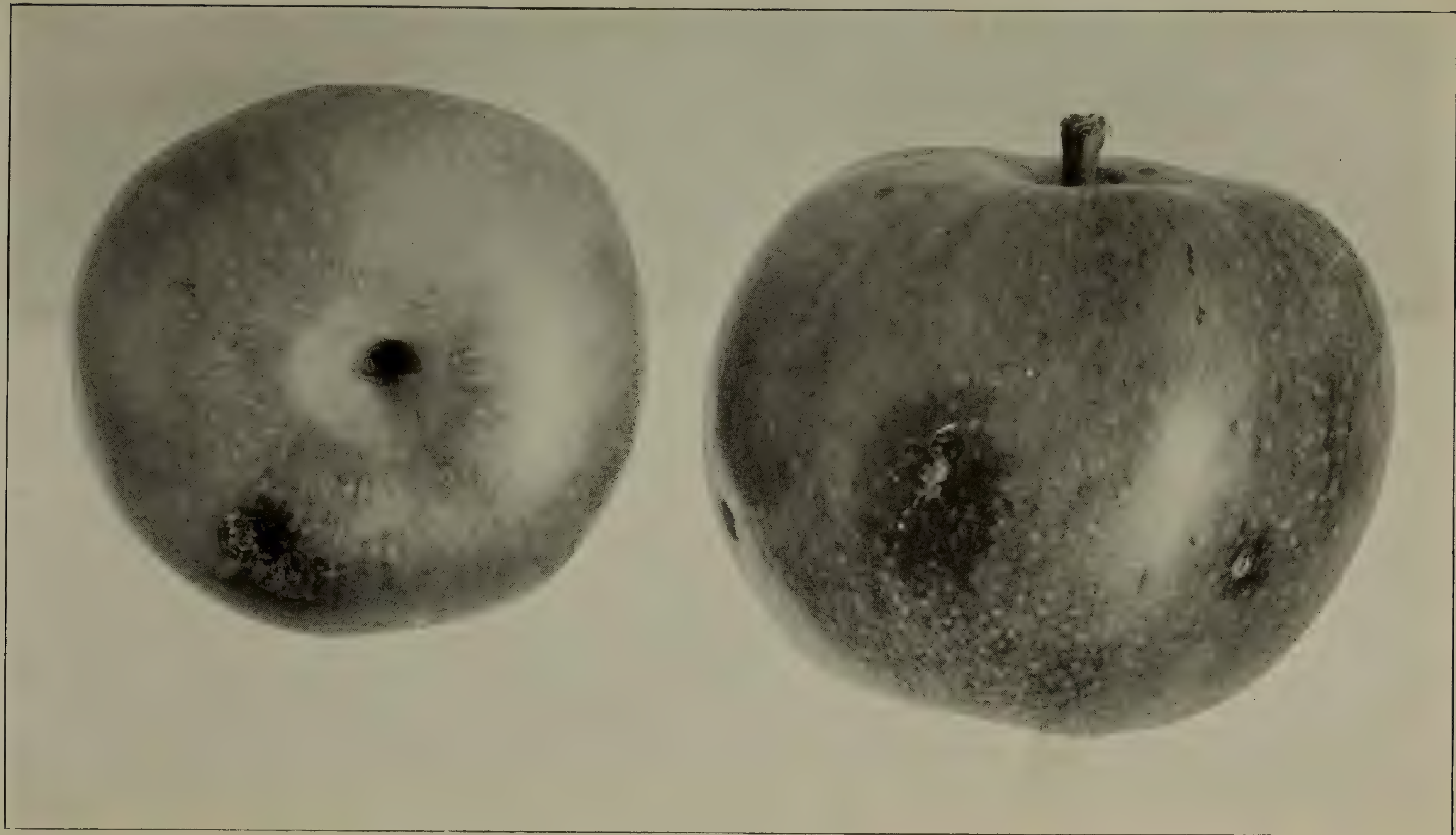
Side-wormy apples

PLATE 4

Codling moth, Carpocapsa pomonella Linn.

Typical side-wormy apples showing fresh borings extruding from the galleries

Plate 4

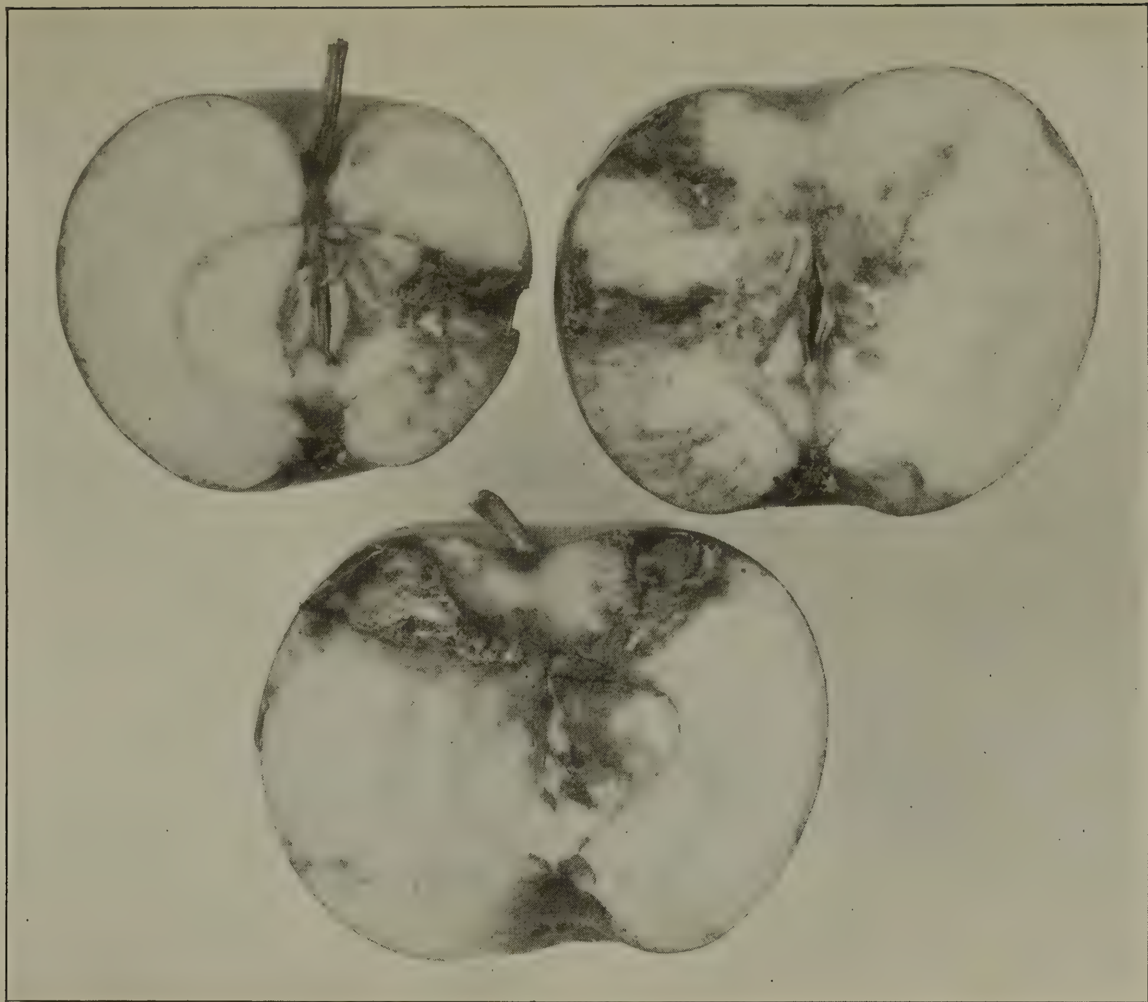


Side-wormy apples showing fresh castings

PLATE 5

Codling moth, C a r p o c a p s a p o m o n e l l a Linn.
Three apples in section showing typical side-worm injury

Plate 5



Side-wormy apples in section

PLATE 6

Bud moth, Tmetocera ocellana Schiff.
Apples showing work of young larvae

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Plate 6

Bud moth injury

PLATE 7

Fruit tree leaf roller, Archips argyrospila Walk. Apples showing early injury by the larvae

Plate 7

Leaf roller work, slight injury

PLATE 8

Fruit tree leaf roller, *Archips argyrospila* Walk. Apples showing early and serious injury

Plate 8

Leaf roller injury

PLATE 9

Fruit tree leaf roller, Archips argyrospila Walk.
Apples showing late injury by the larvae and possibly also the work of the lesser apple worm, Enarmonia prunivora Walsh

Plate 9

Late leaf roller injury

PLATE 10

Rosy aphis, *Aphis sorbi* Kalb.

Group of apples showing characteristic stunting and deformation

Plate 10

Aphis apples

PLATE 11

Work of a sawfly larva

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Plate 11

Hole made by greenish sawfly larva

PLATE 12

White grub, L a c h n o s t e r n a f u s c a Frohl.
Work of larvae in potatoes

Plate 12

Potatoes eaten by white grubs

PLATE 13

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Chrysanthemum midge, Diarthronomyia hypogaea H. Lw.

Chrysanthemum leaves showing the characteristic oval galls

Plate 13

Chrysanthemum midge galls

PLATE 14

Nun midge, Asphondylia monacha O. S.

1 A few galls on the narrow-leaved goldenrod, Solidago graminifolia

2 Bunch of narrow-leaved goldenrod showing numerous galls

Plate 14

1

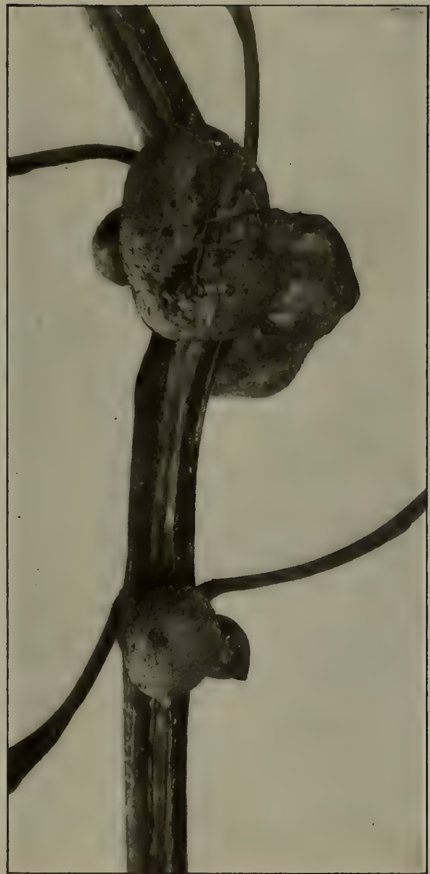
2

Nun midge galls

PLATE 15

1 Gall of *Asphondylia globulus* O. S. on Rudbeckia stem
2 Deformed flower head on Rudbeckia produced by the larvae of *Asphondylia conspicua* O. S. Both from photographs by L. H. Weld

Plate 15



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Midge galls

PLATE 16

1 A Cactus lobe showing exuviae of *Asphondylia opuntiae* Felt, photographed by E. O. Essig

2 Section of lobe of Cactus showing cavities inhabited by *Asphondylia opuntiae* Felt, photographed by E. O. Essig

Plate 16

1

2

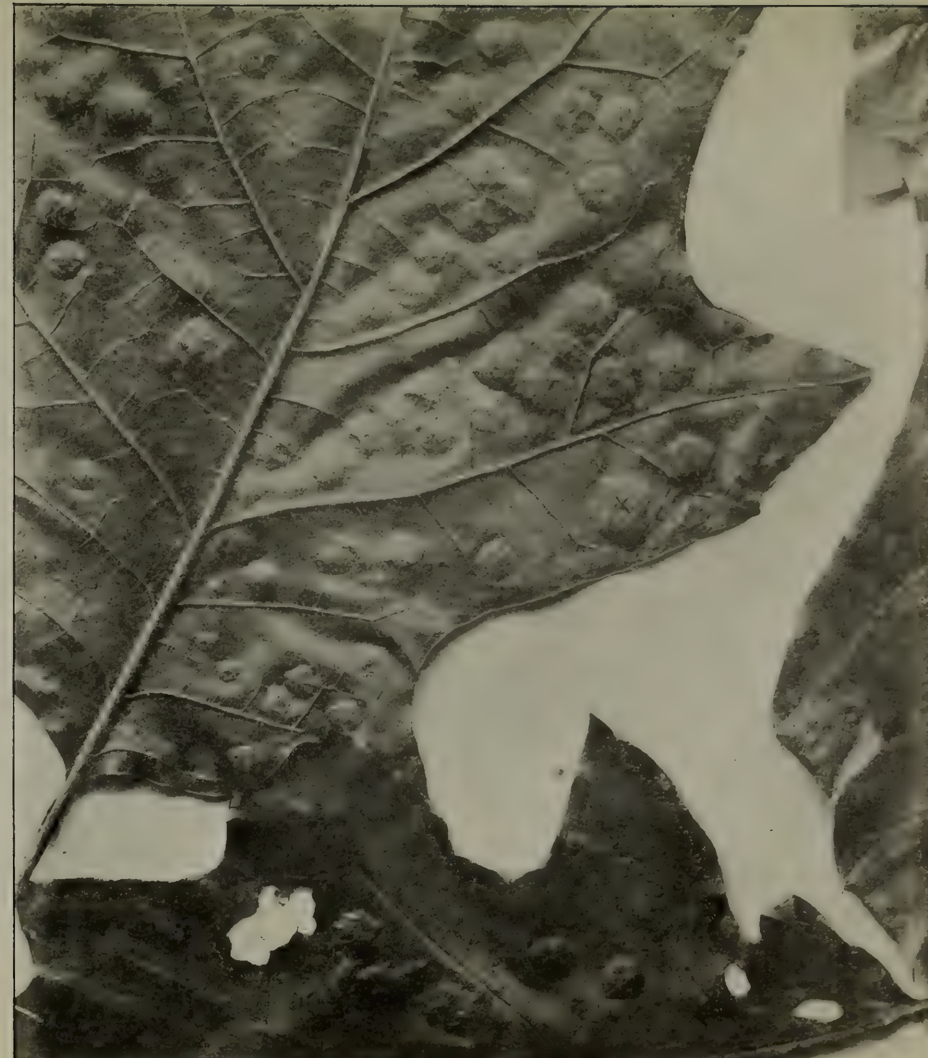
Galls of Asphondylia opuntiae

PLATE 17

1 Clustered bud gall of *Schizomyia coryloides* Walsh & Riley on grape. From photograph by L. H. Weld
2 Pustulate galls of *Cincticornia pustulata* Felt on oak From photograph by Miss Cora H. Clarke

Plate 17

1



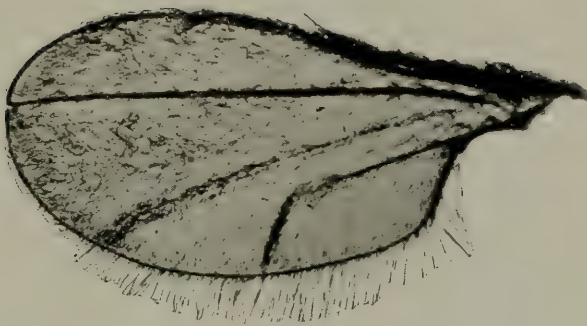
2

Midge galls

PLATE 18

1 Wing of *Asphondylia monacha* O. S., female, x 20
2 Wing of *Asphondylia monacha* O. S., male, x 20
3 Wing of *Schizomyia viburni* Felt, x 20
4 Wing of *Cincticornia transversa* Felt, x 20
5 Male genitalia of *Asphondylia fulvopedalis* Felt, x 260

Plate 18



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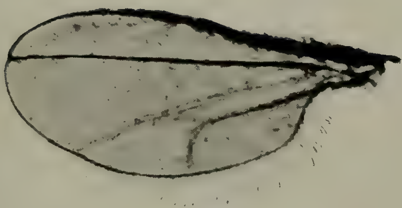

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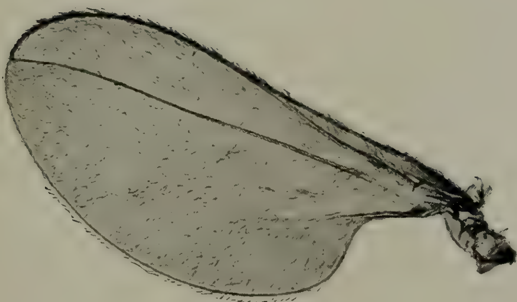

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5

Gall midge structures

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Appendix 4

Botany

Museum Bulletin 188

188 Report of the State Botanist 1915

New York State Museum Bulletin

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Published monthly by The University of the State of New York

No. 188 ALBANY, N. Y. AUGUST 1, 1916

The University of the State of New York
New York State Museum
JOHN M. CLARKE, Director

REPORT OF THE STATE BOTANIST 1915

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The University of the State of New York

Science Department, March 15, 1916

Dr John H. Finley

President of the University

SIR:

I have the honor to transmit herewith for publication as a bulletin of the State Museum the annual report of the State Botanist with the necessary illustrative matter pertaining thereto.

Very respectfully yours

JOHN M. CLARKE

Director

THE UNIVERSITY OF THE STATE OF NEW YORK
OFFICE OF THE PRESIDENT

Approved for publication this 22d day of March 1916

John Finley

President of the University

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New York State Museum

JOHN M. CLARKE, *Director*

REPORT OF THE STATE BOTANIST 1915

John M. Clarke

Director, Science Department

SIR:

I beg to communicate herewith my report on the work of the State Botanist for the fiscal year 1915.

Very respectfully

HOMER D. HOUSE

State Botanist

Scientific investigations. The investigations of the State Botanist during the season of 1915 have been directed chiefly toward the collection, identification and preparation of specimens of plants and fungi for the state herbarium. A limited amount of time has been spent in the study of the vegetation and ecology of the Oneida lake region.

The diversified character of the vegetation of New York has attracted the attention of botanists since the earliest colonial days and since the publication at Upsala between the years 1743 and 1751 of "Plantae Coldenghamiae" by Cadwallader Colden, the earliest publication relating specifically to the flora of this State, down to the present time, over 350 separate articles and books have been published bearing upon the flora of the State by 185 different authors. The growth of scientific societies in most of the larger cities and the progress of botanical work in colleges and universities throughout the State has contributed largely to the study of local floras with a corresponding increase in the publications upon the vegetation of the State. A complete bibliography which may serve

as a source of information regarding the publications upon the flora of the State and as a guide in future investigations seems particularly opportune at this time. Considerable time has been given to the preparation of such a bibliography, which is printed in this report.

Plant diseases. The principal plant diseases caused by fungi which have been submitted to this office have been parasitic leaf diseases of ornamental and shade trees species. The most noteworthy is a disease of the foliage of wild and cultivated clematis caused by Ascochyta clematidina; a disease of oak leaves caused by Gloeosporium canadense and also a peculiar association of an insect gall and Phyllosticta phomiformis; diseases of the leaves of the woodbine or Virginia creeper caused by Cercospora ampelopsidis and Phyllosticta ampelopsidis, and a disease of horse chestnut leaves caused by Phyllosticta paviae. These are illustrated and discussed in another place under " New or Interesting Species of Fungi."

Memoir on the Wild Flowers of New York. Active work upon this project was begun in August and photographs were made in central New York, vicinity of Albany, Catskill, New York, and on Long Island, of over 150 flowering plants which bloom during the latter part of the summer and autumn, using both dry and lumiere plates. Preliminary proofs of several of the illustrations have been received showing the natural color and grace of the wild plants in a manner that could not be secured by any other process. A few of these are published in this report.

Exchanges. Valuable exchanges of herbarium material have been effected whereby the state herbarium has been enriched by the addition of 254 specimens from Prof. J. J. Davis of the University of Wisconsin, 47 specimens from the New York Botanical Garden, 62 specimens from Prof. John Dearness of London, Ont., and 68 specimens from Prof. L. H. Pennington of Syracuse University, in addition to several minor exchanges.

Condition of the collections. With the addition to the staff of Mr Joseph Rubinger, the assistant botanist, it has been possible to place the state herbarium in an excellent condition as regards arrangement and availability of material for study. The collections, exchanges and contributions of the current year have been mounted and placed in the herbarium together with a large quantity of unmounted material which had accumulated in years past.

Additions to the herbarium. The number of specimens which have been added to the herbarium during the past year from current collections is 584, from contributions and exchanges 396, a total of 980 specimens, representing 938 species, in addition to more than 400 additional specimens which have been mounted from the unnamed material accumulated in the past. Of these, 222 species were not previously represented in the herbarium and 30 species and varieties are described as new to science. The number of those who have contributed specimens to the herbarium is 20. This includes those who have sent specimens merely for identification and which were desirable additions to the herbarium.

Identifications. The State Botanist's office has been called upon to identify or report upon 650 specimens of flowering plants, ferns, mosses, lichens and fungi, by 110 different persons.

PLANTS ADDED TO THE HERBARIUM

New to the herbarium

(Flowering plants)

Ammsonia ammsonia (*L.*) *Britton*
Aristida oligantha *Michx.*
Aster inanthinus *Burgess*
" multiformis *Burgess*
" tenebrosus *Burgess*
Carex hormathodes *Fernald*
Cathartolinum sulcatum (*Ridell*) *Small*
Chaenorrhinum minus (*L.*) *Lange*
Chamaesyce glyptosperma (*Engelm.*) *Small*
Crepis biennis *Linn.*
Elymus glaucus *Buckley*
Galeopsis ladanum *L. var.* latifolia *Wallr.*
Hypericum densiflorum *Pursh*
Panicum ashei *Pearson*
" commonsianum *Ashe*
" lindheimeri *Nash*
Polygonum buxiforme *Small*
" prolificum (*Small*) *Robinson*
Pyrola asarifolia *Michx.*
Tagetes erecta *Linn.*

(Fungi)

Acanthostigma occidentale *E. & E.*
Aecidium laricis *Kleb.*
" liatridis *Ell. & And.*
Aleurodiscus farlowi *Burt*
Ascochyta lophanthi *Davis*
" pisi Lib., *f.* lupini *Sacc.*
" wisconsina *Davis*

Basidiophora entospora *Roze & Cornn.*
Botryosphaeria fuliginosa *M. & N.*

Caeoma stobilinum *Arthur*
Calosphaeria cornicola *E. & E.*
Cercospora althaeina *Sacc.* var. praecincta *Davis*
" caricina *Ell. & Dearn.*
" caricis *Dearness & House*
" ceanothi *Kell. & sw.*
" cercidicola *Ellis*
" comandrae *Ell. & Dearn.*
" diffusa *E. & E.*
" dioscoreae *E. & M.*
" fingens *Davis*
" gayophyti *E. & E.*
" geranii *Kell. & Sw.*
" megalopotanica *Speg.*
" negundinis *E. & E.*
" omphacodes *Ell. & Holw.*
Cercospora passaloroides *Wint.*
" pentstemonis *E. & K.*
" perfoliata *E. & E.*
" sagittariae *Ell. & Kell.*
" sequoiae var. juniperi *E. & E.*
" stomaticae *Ell. & Davis*
Cintractia subinclusa (*Koern.*) *Magn.*
Coleosporium viburni *Arthur*
Coletotrichum graminicolum (*Ces.*) *Wils.*
Cornularia persicae (*Schw.*) *Sacc.*
Corticium atrovirens *Berk.*
" epigaeum *E. & E.*
" laetum *Karst.*
" roseopallens *Burt*
Coryneum umbonatum *Nees*
Craterellus ochrosporus *Burt*
Cucurbitaria ceanothi *D. & H.*
Cylindrosporium apocyni *E. & E.*
" betulae *Davis*
" clematidis *E. & E.*
" eryngii *Ell. & Kell.*
" glyceriae *E. & E.*
" negundinis *E. & E.*
" shepherdiae *Sacc.*
" vermiforme *Davis*
Cyphella conglobata *Burt*

Darluca bubakiana *Kabat*
Dendrophoma albomaculans (*Schw.*) *Starb.*
Diaporthe ailanthi *Sacc. var.* viburni *Dearness & House*
" comptonae (*Schw.*) *E. & E.*
" minuta *Dearness & House*
" tuberculosa (*Ell.*) *Sacc.*
" *var.* pruni *Dearness & House*
Didymosphaeria empetri (*Fr.*) *Sacc.*
" housei *Dearness*
Diplodia ceanothi *Dearness & House*
" microspora *B. & C.*
Dothidella vacciniicola *Dearness & House*
Doaassansia ranunculina *Davis*

Eichleriella leveilliana (*B. & C.*) *Burt*
Entomosporium thumeni (*Cke.*) *Sacc.*
Entyloma floerkeae *Holway*
Eutypa ludibunda *Sacc.*
Eutypella stellulata (*Fr.*) *Sacc.*

Fabraea rousseauana *Sacc. & Bomm.*
Flammula penetrans *Fr.*
Fusicladium radiosum *var.* microscopium (*Sacc.*) *Allesch.*

Gloeosporium alnicola *Dearness & House*
" argemonis *E. & E.*
" aridum *Ell. & Holw.*
" catalpae *E. & E.*
" confluens *Ell. & Dearn.*
" cylindrosporium (*Bon.*) *Sacc.*
" falcatum *Dearness & House*
" hydrophylli *Dearness & House*
" saccharinum *E. & E.*
" thalictri *Davis*
Gnomonia beneta (*Sacc. & Speg.*) *Kleb.*
Gymnosporangium davisii *Kern*
" juvenescens *Kern*

Hypochnus olivascens (B. & C.) *Burt*
" subferrugineus *Burt*

Keithia thujina *Durand*
" tsugae *Farlow*

Lactaria mucida *Burlingham*
Leptonia euchlora (*Lasch*) *Quel.*
Leptosphaeria triglochinis *Schroet.*

Macrophoma viburni *Dearness & House*
Marsonia fraxini *Ell. & Davis*
Marsonia neilliae (*Harkness*) *Magn.*
" marini (*S. & E.*) *Magn.*
Massaria plumigera *var.* tetraspora *Dearness & House*
Metasphaeria varia *Dearness & House*

Nigredo rhyncosporae (*Ellis*) *Arthur*

Ovularia asperifolii *Sacc. var.* lapulae *Davis*
" destructiva (*Phil. & Plowr.*)
Peniophora affinis *Burt*
" crassa *Burt*
" longispora *Pat.*
" laevis (*Fr.*) *Burt*
" sanguinea *Fr.*
" sordida *Karst.*
Peronospora calotheca *DeBary*
" polygoni *Thüm.*
" rubi *Rabenh.*
" viciae (*Berk.*) DeBy. *var.* americana *Davis*
Pestalozzia flagellifera *E. & E.*
Phleospora celtidis *Ell. & Mart.*
" chenopodii *E. & K.*
Phoma florida *Dearness & House*
" imperalis *Sacc. & Roum.*
" linariae *Dearness & House*
" longipes *B. & C.*
" pectinata *Dearness & House*
" platinocola *D. & H.*
Phyllosticta ambrosiodes *Thüm.*
" destruens *Desm.*
" lentaginis *Sacc. & Syd.*
" punctata *Ell. & Dearn.*
" simillispora *Ell. & Davis*
" steironematis *Dearness & House*

Physalospora ambrosiae *E. & E.*
Protomyces andinus *Speg.*
Plasmopara humuli *Miyabe & Takahashi*
" ribicola *Schroet.*
Phytophthora thalictri *Wils. & Davis*
Puccinia conii (*Strauss*) *Fckl.*
" cyperi *Arthur*
" milii *Erikss.*
" ornata *Arthur & Holw.*
" panici *Dietel.*
" perminuta *Arthur*
" poarum *Niels*
" pygmea *Erikss.*
" rubifaciens *Johans.*
" sessilis *Schw.*
" seymouriana *Arthur*
" tetramerii *Seym.*
" tomipara *Trelease*
" windsoriae *Schw.*

Ramularia brunellae *E. & E.*
" cichorii *Dearness & House*
" lysimachiae *Thüm.*
" puntiformis (*Schl.*) *var. Hoehn.*
" reticulata *E. & E.*
" rosea (*Fckl.*) *Sacc.*
" smilacinae *Davis*
" uredinis (*Voss*) *Sacc.*
" virgaureae *Thüm.*

Sclerotium globuliferum *Davis*
Scolescosporium coryli *Dearness & House*
Septoria acerella *Sacc.*
" asclepiadicola *E. & E.*
" astericola *E. & E.*
" brevispora *Ell. & Davis*
" brunellae *Ell. & Holw.*
" cephalanthi *Ell. & Kell.*
" consimilis *E. & M.*
" davisii *Sacc.*
Septoria dimera *Sacc.*
" dolichospora *E. & E.*
" helenii *E. & E.*
" lophanthi *Wint.*
" mollisia *Dearness & House*
" nubilosa *E. & E.*
" pachyspora *Ell. & Holw.*
" parietariae *Davis*
" physostegiae *E. & E.*
" polaris *Karst.*
" polymniae *E. & E.*
" prenanthis *E. & E.*
" rudbeckiae *Ell. & Holw.*
" silphii *E. & E.*
" salicifoliae (*Trel.*) *Berl. & DeToni*
" stachydis *R. & D.*
" tenuis *Dearness & House*
" zanthiifoliae *Ell. & Kell.*
Sphaerella ciliata *E. & E.*
Sphaeropsis ailanthi *Ell. & Barth.*
" ceanothi *Dearness & House*
" coryli *E. & E.*
" parallela *Dearness & House*
" physocarpi *E. & E.*
" viburni-dentati *Dearness & House*
Stagonospora convolvuli *Dearness & House*
Synchytrium scirpi *Davis*

Taphrina potentillae (*Farlow*) Johans.
Thelephora scissilis *Burt*

Urocystis agropyri (*Preuss.*) *Schroet.*
Uromyces galphiniae *Diet. & Holw.*
" poinsettiae *Tranz.*
" rudbeckiae *A. & H.*

Vermicularia polygoni-virginici *Schw.*

Not New to the Herbarium

Aecidium ceanothi *Ell. & Kell.*
" chelonis *Ger.*
" compositarum *Mart.*
" euphorbiae *Pers.*
" falcatae *Arthur*
Aecidium hydnoideum *B. & C.*
" lupini *Peck*
" nesaeae *Ger.*
" proserpinaceae *B. & C.*
" roestelioides *E. & E.*

Aecidium senecionis *Desm.*
Agaricus diminutivus *Peck*
" placomyces *Peck*
" sylvicola *Vitt.*
Albugo candida (*Pers.*) *Kuntze*
" tragopogonis (*DC.*) *S. F. Gray*
Antrodia mollis (*Sommerf.*) *Karsten*
Ascochyta clematidina *Thüm.*
" colorata *Peck*
Asterina gaultheriae *Curt.*
" rubicola *E. & E.*
Asterostroma cervicolor (B. & C.) Massee

Bactridium flavum *Kze. & Schum.*
Bjerkandera adusta (*Willd.*) *Karst.*
Boletinus pictus *Peck*
Burrillia pustulata *Setch.*

Calyptospora columnaris (*A. & S.*) *Kuhn*
Cercospora apocyni *E. & K.*
" beticola *Sacc.*
" boehmeriae *Peck*
" callae *Peck*
" comari *Peck*
" condensata *Ell. & Kell.*
" diffusa *E. & E.*
" echinocystis *E. & M.*
" effusa (*B. & C.*) *E. & E.*
" gerardiae *Ell. & Dearn.*
" granuliformis *Ell. & Kell.*
" gymnocladi *Ell. & Holw.*
" longispora *Peck*
" physalidis *Ellis*
" pyri *Farlow*
" racemosa *Ell. & Mart.*
" rhamni *Fckl.*
" ribicola *E. & E.*
" symplocarpi *Peck*
" zebrina *Pass.*
Cercosporella apocyni *Ell. & Kell.*
Ceriomyces subglabripes (*Peck*) *Murrill*
Chanterel infundibuliformis (*Scop.*) *Fr.*
" muscoides (*Wulf.*) *Murrill*
" umbonatus *Fr.*
Chlorosplenium aeruginosum (*Oed.*) *DeNot.*
Cladosporium ramulosum *Desm.*
" typhae *Schw.*
Claudopus nidulans (*Pers.*) *Peck*
Clavaria mucida *Pers.*
" pinophila *Peck*
" pistillaris *Linn.*
Clitocybe clavipes (*Pers.*) *Fr.*
" sinopica *Fr.*
Clitopilus abortivus *B. & C.*
Coleosporium sonchi-arvenis (*Pers.*) *Lev.*
" solidaginis (*Schw.*) *Thüm.*
Collybia dryophila *Bull.*
" maculata *A. & S.*
" strictipes *Peck*
" tuberosa *Bull.*
Coniophora arida *Fr.*
" puteana *Schum.*
" olivescens (*B. & C.*) *Massee*
" suffocata *Peck*
Coniothyrium concentricum *Desm.*
Corticium effuscatum *C. & E.*
" alutaceum (*Schrad.*) *Bres.*
" berkeleyi *Cooke*
" colliculosum *B. & C.*
" mutatum *Peck*
" evolvens *Fr.*
" sambuci *Fr.*
" fumosum *Fr.*
" investiens (*Schw.*) *Bres.*
" vagum *B. & C.*
Cortinarius armillatus *Fr.*
Craterellus cornucopioides *Pers.*
" odoratus (*Schw.*) *Fr.*
Cronartium comandrae *Peck*
" quercus (*Brond.*) *Schroet.*
Cryptospora aculeans (*Schw.*) *E. & E.*
Cudonia lutea (*Peck*) *Sacc.*
Cyphella fasiculata (*Schw.*) *B. & C.*
Cytospora rhoina *Fr.*

Daedalea quercina (*L.*) *Pers.*
Daldinia concentrica (*Bolt.*) *Ces. & DeNot.*
Dendrophoma cephalanthi *Peck*

Diaporthe acerina (*Pk.*) *Sacc.*
" obscura *Peck*
Diatrype stigma (*Hoffm.*) *Fr.*
Dimerosporium melioloides (*B. & C.*)
Diplodia cercidis *E. & E.*
" linderae *E. & E.*
Discosia maculicola *Ger.*
Doassansia alismatis (*Nees*) *Cornn.*
" affinis *Ell. & Dearn.*
" deformans *Setch.*
" martianoffiana (*Thüm.*) *Schult.*

Elaphomyces variegatus *Tul.*
Elfvingia fomentaria (*L.*) *Murrill*
Entyloma compositarum *Farlow*
" lineatum (*Cooke*) *Davis*
" menispermi *Farlow*
" microsporum (*Ung.*) *Schroet.*
" nymphaeae (*DC.*) *Setch.*
" ranunculi (*Bon.*) *Schroet.*
" thalictri *Schroet.*
" physalidis (*Kl. & Cke.*) *Wint.*
Erysiphe martii *Link*
Eutypella glandulosa *Cooke*
Exoascus communis *Sadeb.*
" betulinus (*Rost.*) *Sadeb.*
" insitiae *Sadeb.*

Flammula carbonaria *Fr.*
Fomes populinus (*Schum.*) *Cooke*
" roseus (*Alb. & Schw.*) *Cooke*
" scutellatus (*Schw.*) *Cooke*
Fomitiporia prunicola *Murrill*
Fusarium heterosporum *Nees*
Fusicladium depressum *B. & Br.*

Geaster triplex *Jungh.*
Gelatinopoium abietinum *Peck*
Gloeophyllum hirsutum (*Schaeff.*) *Murrill*
" trabeum (*Pers.*) *Murrill*
Gloeosporium betularum *Ell. & Mart.*
" canadense *E. & E.*
" caryae *Ell. & Dearn.*
" coryli (*Desm.*) *Sacc.*
" divergens *Peck*
Gloeosporium nervicolum *G. Massal*
" robergii *Desm.*
" salicis *West.*
" sassafras (*Cooke*) *E. & K.*
" septorioides *Sacc.*
" trifolii *Peck*
Gnomonia beneta (*Sacc. & Speg.*) *Kleb.*
Gnomoniella eccentrica (*C. & P.*) *Sacc.*
Grandinia virescens *Peck*
Gymnosporangium clavaeaeforme (*Jacq.*) *DC.*
" globosum *Farlow*

Hapalopilus gilvus (*Schw.*) *Murrill*
" rutilans (*Pers.*) *Murrill*
Hendersonia staphyleae *E. & E.*
Holwaya gigantea (*Peck*) *Dur.*
Hydnum caput-ursi *Fr.*
" schiedermayeri (*Heufler*)
Hygrophorus fuligineus *Frost*
" pratensis (*Pers.*) *Fr.*
Hyphoderma commune (*Fr.*) *Duby*
Hypholoma fasciculare (*Huds.*) *Fr.*
Hypochnus granulosus (*Peck*) *Burt*
" fuscus (*Pers.*) *Fries*

Kuehneola ureninis (*Lk.*) *Arthur*

Lachnea hemisphaerica (*Wiggs.*) *Gill.*
Lactaria gerardii *Peck*
" ligniota *Fr.*
" subdulcis (*Pers.*) *Fr.*
" theiogala (*Bull.*) *Fr.*
" torminosa (*Schaeff.*) *Pers.*
" turpis (*Weinm.*) *Fr.*
Lenzites betulina (*L.*) *Fr.*
Leottia lubrica (*Scop.*) *Pers.*
Lepiota amianthina (*Scop.*) *Quell.*
" clypeolaria (*Bull.*) *Quell.*
Leptosphaeria doliolum *Pers.*
Leptothyrium periclymeni *Desm. var.* americana *E. & E.*
Leptostrimella hysterioides (*Fr.*) *Sacc.*
Libertiella betulina *Desm.*

Macrosporium saponariae *Peck*
" solani *E. & M.*
Marasmius confluens (*Pers.*) *Rickens*
Marsonia coronariae *Sacc. & Dearn.*
" juglandis (*Lib.*) *Sacc.*
" potentillae (*Desm.*) *Magn.*
" violae (*Pass.*) *Magn.*
Massaria vomitoria *B. & C.*
Melampsora medusae *Thüm.*
Melampsorella elatina (*Alb. & Schw.*) *Arthur*
Melampsoropsis ledi (*Lk.*) *Arthur*
" ledicola (*Pk.*) *Arthur*
Melanconium elongatum *Berk.*
Melanoleuca albissima (*Peck*) *Murrill*
" sejuncta (*Sow.*) *Murrill*
Merulius tremellosus *Schrad.*
" bellus *B. & C.*
Microsphaera vaccinii (*Schw.*) *C. & P.*
" alni (*Wallr.*) *Wint.*
Morchella semilibera *DC.*
Mycena epipterygia *Scop.*

Nigredo hedysari-paniculati (*Schw.*) *Arthur*
" polemonii (*Pk.*) *Arthur*
" proeminens (*DC.*) *Arthur*
" pyriformis (*Cke.*) *Arthur*
" spermacoces (*Schw.*) *Arthur*
Nummularia clypeus (*Schw.*) *Cooke*

Odontia trachytricha (*E. & E.*) *Burt*
Omphalia campanella *Batsch.*
" chrysophylla *Fr.*

Peniophora cinerea *Fr.*
" filamentosa (*B. & C.*) *Burt*
" incarnata *Fr.*
" pubera *Fr.*
" sanguinea *Fr.*
" velutina *DC.*
Peridermium comptoniae (*Arth.*) *Orton & Adams*
" balsamium *Peck*
Peronospora arthuri *Farlow*
" corydalis *DeBary*
" effusa (*Grev.*) *Rabh.*
" grisea *Ung.*
" hydrophlli *Waite*
" leptosperma *DeBary*
" lophanthi *Farlow*
" trifoliorum *DeBary*
Pestalozzia guepini *Desm.*
" monochaetoides *Sacc. & Ell.*
Phlebia radiata *Fr.*
Phleospora chenopodii *E. & K.*
" ulmi (*Fr.*) *Wallr.*
Pholiota caperata (*Pers.*) *Fr.*
" squarrosa *Muell.*
Phoma ailanthi *Sacc.*
" longipes *B. & C.*
" verbasicola (*Schw.*) *Sacc.*
Phragmidium occidentale *Arthur*
Phyllosticta ampelopsidis *E. & M.*
" apocyni *Trelease*
" chenopidii *Sacc.*
" cruenta (*Fr.*) *Kickx.*
" hamamelidis *Peck*
" innumerabilis *Peck*
" labruscae *Thüm.*
" liriodendri *Cooke*
" macrospora *E. & E.*
" minima *B. & C.*
" myricae *Cooke*
" paviae *Desm.*
" phomiformis *Sacc.*
" podophylli *Wint.*
" smilacis *E. & M.*
Phyllachora wittrockii (*Erikss.*) *Sacc.*
Physalospora ceanothina (*Peck*) *Sacc.*
" disrupta (*B. & C.*) *Sacc.*
Piggotia fraxími *B. & C.*
Piricularia parasitica *E. & E.*
Plasmopara geranii *Peck*
" halstedii (*Farlow*) *Berl. & DeToni*
" pygmaea (*Ung.*) *Schroet.*
" viticola (*B. & C.*) *Berl. & DeToni*

Pleurotus porrigens *Pers.*
" serotinus *Schrad.*
Polyporus dichrous *Fr.*
Poria calcea *Fr.*
" radula (*Pers.*) *Fr.*
" pulchella *Schw.*
" vaporaria *Fr.*
" vulgaris *Fr.*
Porodisculus pendulus (*Schw.*) *Murrill*
Puccinia angustata *Peck*
" asteria *Duby*
" balsamorhizae *Peck*
" bardanae *Corda*
" bullata (*Pers.*) *Wint.*
" canaliculata (*Schw.*) *Lagenh*
" circaeae *Pers.*
" cirsii *Lasch.*
" convolvuli (*Pers.*) *Cast.*
" cryptotaeniae *Peck*
" curtipes *Howe*
" eatoniae *Arthur*
" eleocharidis *Arthur*
" eriophori *Thüm.*
" extensicola *Plowr.*
" dayi *Clinton*
" dulichii *Sydow*
" eleocharidis *Arthur*
" emaculata *Schw.*
" gigantispora *Bubak.*
" grosulariae (*Pers.*) *Lagenh.*
" heucherae (*Schw.*) *Diet.*
" impatientis (*Schw.*) *Arthur*
" iridis (*DC.*) *Wallr.*
" malvacearum *Mont.*
" melanconoides *Ell. & Hark.*
" menthae *Pers.*
" mesomegala *B. & C.*
" obscura *Schroet.*
" osmorrhizae (*Pk.*) *C. & P.*
" physalidis *Peck*
" pimpinellae *Mart.*
" podophylli *Schw.*
" polygalae *Paschke*
" polygoni-amphibi *Pers.*
" proserpinaceae *Farlow*
" puculiformis (*Jacq.*) *Wettst.*
" pustulata *Arthur*
" saniculae *Grev.*

Puccinia silphii *Schw.*
" simillima *Arthur*
" suaveolens (*Pers.*) *Rostr.*
" taraxaci *Plowr.*
" tenue (*Schw.*) *Burrill*
" triticina *Erikss.*
" violae (*Schw.*) *DC.*
" xanthi *Schw.*
Pucciniastrum agrimoniae (*Schw.*) *Tranz.*
" articum (*Lagh.*) Tranz. *var.* americana *Farl.*
Pseudopeziza medicaginis (*Lib.*) *Sacc*
Pseudovalsa lanciformis (*Fr.*) *Ces. & DeNot.*
Pycnoporus cinnabarinus (*Jacq.*) *Karst.*

Ramularia arvensis *Sacc.*
" barbarae *Peck*
" hammamelidis *Peck*
" nemopanthis *C. & P.*
" obovata *Fckl.*
" occidentalis *E. & K.*
" plantaginis *E. & M.*
" prini *Peck*
" spiraeae *Peck*
" stoloniferae *E. & E.*
Rhinotrichum curtisii *Berk.*
Rhizina inflata (*Schaeff.*) *Quel.*
Rhytisma ilicis-canadensis *Schw.*
" andromedae (*Pers.*) *Fr.*
" punctata (*Pers.*) *Fr.*
Rostkovites granulatus (*L.*) *P. Karst.*
" subaureus (*Pk.*) *Murrill*
Russula compacta *Frost & Peck*
" depallens (*Pers.*) *Fr.*
" foetens (*Pers.*) *Fr.*
" lutea (*Huds.*) *Fr.*

Schizonella melanogramma (*DC.*) *Schroet.*
Sclerotium bifrons *E. & E.*
Scolecotrichum maculicolum *E. & K.*
Scleroderma verrucosa (*Bull.*) *Pers.*
" vulgare *Hornem.*

Septogloeum ampelopsidis *E. & E.*
" nuttalii *Harkness*
" ochroleucum (*B. & C.*) *Dearness*
Septoria anemones *Desm.*
" alnifolia *E. & E.*
" apii (*B. & C.*) *Chester*
" atropurpurea *Peck*
" bruneola (*Fr.*) *Niessl.*
" cerastii *Rob. & Desm.*
" consimilis *E. & M.*
" conspicua *E. & M.*
" cornicola *Desm.*
" dentaria *Peck*
" erigerontis *Peck*
" gei *R. & D.*
" lactucae *Pass.*
" lactucicola *E. & M.*
" ludwigiae *Cooke*
" menyanthis *Desm.*
" musiva *Peck*
" nabali *B. & C.*
" osmorrhizae *Peck*
" polygonorum *Desm.*
" speculariae *B. & C.*
" rubi *West.*
" rubi *West. var.* pallida *Ell. & Holw.*
" rumicis *Ellis*
" sambucina *Peck*
" salicis *West.*
" vebeneae *Rob. & Desm.*
" solidaginicola *Peck*
" violae *West.*
" viridi-tingens *Curt.*
" wilsoni *Clinton*
Spathularia velutipes *C. & F.*
Sphaeropsis biformis *Peck*
" menispermi *Peck*
" sepulta *E. & E.*
" sumachi (*Schw.*) *C. & E.*
Sphaerotheca humuli (*DC.*) *Burr.*
Spongospora subterranea (*Wallr.*) *Johnson*
Steıeum rameale *Schw.*
Stigmatea robertiana *Fr.*
Synchytrium decipiens *Farlow*
" aureum *Schroet.*

Taphrina caerulescens (*Desm. & Mont.*) *Tul.*
" potentilliae (*Farlow*) *Johans.*
Thelephora caryophyllea *Schaeff.*
" cuticularis *Berk.*
" intybacea *Pers.*
" spiculosa *Fr.*
" terrestris *Ehrh.*
" vialis *Schw.*
Trametes abietis *Karsten*
" piceina *Peck*
Tyromyces guttulatus (*Peck*) *Murrill*

Uredinopsis atkinsonii *Magn.*
" mirabilis (*Pk.*) *Magn.*
" osmundae *Magn.*
" struthiopteris *Magn.*
Urocystis anemones (*Pers.*) *Wint.*
" waldsteiniae *Peck*
Urophylictis pulposa (*Wallr.*) *Schroet.*
Ustilago heufleri *Fckl.*
" longissima (*Sow.*) *Tul.*
" lorentziana *Thüm.*
" perennans *Rostr.*
" rabenhorstiana *Keuhn.*
" residua *Clinton*
" utriculosa (*Nees*) *Tul.*
" violacea (*Pers.*) *Ung.*
" zeae (*Beckm.*) *Fckl.*
Uromyces rudbeckiae *A. & H.*
" trifolii-repentis (*Cast.*)

Valsa ambiens (*Pers.*) *Fr.*
" leucostoma (*Pers.*) *Fr.*
" nivea (*Hoffm.*) *Fr.*
" opulifoliae *Peck*
" subclypeata *C. & P.*
Valsaria exasperans *Ger. var.* aceris *Rhem.*
Venenarius frostianus (*Peck*) *Murrill*
" phalloides (*Fr.*) *Murrill*
Venturia cassandae *Peck*
Vermicularia compacta *C. & E.*
" coptina *Peck*
" liliacearum *West.*

Xylaria polymorpha *Fr.*

(Ferns and flowering plants)

Agalinis maritima *Raf.*
" purpurea *(L.) Britton*
" tenuifolia *(Vahl) Raf.*
Agrimonia striata *Michx.*
Agrostis alba *Linn.*
Aletris farinosa *Linn.*
Alsine graminea *(L.) Britton*
Althaea officinalis *Linn.*
Ammophila arenaria *(L.) Link*
Anchistea virginica *(L.) Presl.*
Andropogon furcatus *Muhl.*
Anemone cylindrica *A. Gray*
Anemone quinquifolia *Linn.*
Antennaria canadensis *Greene*
" ambigens *(Greene) Fernald*
" fallax *Greene*
" grandis *(Fernald) House*
" neodioica *Greene*
" neglecta *Greene*
" occidentalis *Greene*
" parlinii *Fernald*
" petaloidea *Fernald*
" plantaginifolia *(L.) Richards*
Apocynum androsaemifolium *Linn.*
Aralia nudicaulis *Linn.*
Arenaria serpyllifolia *Linn.*
Aristida dichotoma *Michx.*
" tuberculosa *Nutt.*
Aronia atropurpurea *Britton*
Asplenium ruta-muraria *Linn.*
Aster acuminatus *Michx.*
" cordifolius *L.*
" concinnus *Willd.*
" divaricatus *L.*
" dumosus *L.*
" ericoides *Linn.*
" lateriflorus *(L.) Britton*
" puniceus *Linn.*
" salicifolius *Lam.*
" spectabilis *Ait.*
" subulatus *Michx.*
Atriplex hastatus *Linn.*
Azolla caroliniana *Willd.*

Baccharis halimifolia *Linn.*
Barbara barbara *(L.) Macm.*
" stricta *Andrz.*
Bartonia virginica *(L.) B. S. P.*
Berberis vulgaris *Linn.*
Boehmeria cylindrica *(L.) Sw.*
Brachyelytrum erectum *(Schreb.) Beauv.*

Cakile edentula *(Bigel.) Hook.*
Caltha palustris *Linn.*
Capnoides sempervirens *(L.) Pers.*
Cardamine pennsylvanica *Muhl.*
" pratensis *Linn.*
Carex albicans *Willd.*
" annectans *Bicknell*
" arctata *Boott*
" communis *Bailey*
" comosa *Boott*
" crinita *Lam.*
" deweyana *Schw.*
" diandra *Schr.*
" gracillima *Schw.*
" interior *Bailey*
" intumescens *Rudge*
" lacustris *Willd.*
" leptalea *Wahl.*
" normalis *Mackenzie*
" oblita *Steud.*
" oederi *Ehrh.*
" pauciflora *Lightf.*
" rosaeoides *E. C. Howe*
" scoparia *Schr.*
" stipata *Muhl.*
" trichocarpa *Muhl.*
" umbellata *Schk.*
" vestita *Willd.*
" vulpinoidea *Michx.*
Carum carui *Linn.*
Cassia marylandica *Linn.*
Cathartolinum medium *(Planch) Small*
Centaurea nigra *Linn.*
Chamaenerion angustifolium *(L.) Scop.*
Chamaesyce polygonifolia *(L.) Small*
" preslii *(Guss.) Arthur*
Cheirinia cheiranthoides *(L.) Link*
Chenopodium ambrosioides *Linn.*
" glaucum *Linn.*
" hybridum *Linn.*
Chrysopsis mariana *(Pursh) Nutt.*
Chimaphila umbellata *(L.) Nutt.*

Collinsonia canadensis *Linn.*
Convolvulus arvensis *Linn.*
Coptis trifolia (*L.*) *Salisb.*
Cornus amonum *Mill.*
" canadensis (*L.*)
Crocanthemum canadense (*L.*) *Britton*
" majus (*L.*) *Britton*
Cuscuta gronovii *Willd.*
Cynoglossum officinale *Linn.*
Cyperus filicinus *Vahl*
" speciosus *Vahl*
" strigosus *Linn.*
Cypripedium spectabile *Salisb.*

Danthonia compressa *Austin*
" spicata (*L.*) *Beauv.*
Dasiphora fruticosa (*L.*) *Rydb.*
Dasystoma flava (*L.*) *Wood.*
" pedicularia (*L.*) *Benth.*
" virginica (*L.*) *Britton*
Decodon verticillata *Linn.*
Dentaria diphylla *Michx.*
Deringia canadensis (*L.*) *Kuntze*
Diodia teres *Walt.*
Distichlis spicata (*L.*) *Greene*
Doellingeria umbellata (*Mill.*) *Nees*
Drosera intermedia *Hayne*
Dryopteris cristata (*L.*) *A. Gray*
" dilatata (*Hoffm.*) *A. Gray*
" dryopteris (*L.*) *Britton*
" intermedia (*Muhl.*) *A. Gray*
" spinulosa (*Muell.*) *Kuntze*
Dulichium arundinaceum (*L.*) *Britton*

Echinochloa walteri (*Pursh.*) *Nash*
Eleocharis palustris (*L.*) *R. & S.*
Eleusine indica (*L.*) *Gaertn.*
Elymus canadensis *Linn.*
Epigaea repens *Linn.*
Epilobium coloratum *Muhl.*
" hirsutum *Linn.*
" lineare *Muhl.*
Equisetum littorale *Kuehl.*
Eriophorum tenellum *Nutt.*
" viridi-carinatum (*Engelm.*) *Fernald*

Eupatorium verbenaefolium *Linn.*
Euthamia graminifolia (*L.*) *Nutt.*

Festuca elatior *Linn.*
Fimbristylis autumnalis (*L.*) *R. & S.*
Fragaria americana (*Porter*) *Britton*

Galeopsis tetrahit *Linn.*
Galium claytoni *Michx.*
" palustre *Linn.*
Geum strictum *Ait.*
Gnaphalium uliginosum *Linn.*
Gratiola aurea *Muhl.*

Helianthus angustifolius *Linn.*
" divaricatus *Linn.*
" strumosus *Linn.*
Hibiscus moscheutos *Linn.*
Hieracium canadense *Michx.*
" paniculatum *Linn.*
" venosum *Linn.*
Hipposelinum levistacum (*L.*) *Britt. & Rose*
Hordeum jubatum *Linn.*

Ibidium cernuum (*L.*) *House*
Ilex laevigata (*Pursh*) *A. Gray*
" montana (*T. & G.*) *A. Gray*
Impatiens biflora *Walt.*
Iva frutescens *Linn.*

Jeffersonia diphylla (*L.*) *Pers.*
Juniperus depressa *Pursh*

Kneiffia pumila (*L.*) *Spach.*
Koellia incana (*L.*) *Kuntze*

Lactuca spicata (*Lam.*) *Hitchc.*
Lappula virginiana (*L.*) *Greene*
Lathyrus maritimus (*L.*) *Bigel.*
" myrtifolius *Muhl.*
Lechea minor *Linn.*
Leptandra virginica (*L.*) *Nutt.*
Lespedeza capitata *Michx.*
" frutescens (*L.*) *Britt.*
" hirta (*L.*) *Hornem.*
" stuvei *Nutt.*
" virginica (*L.*) *Britton*
Lilium canadense *Linn.*
Limonium carolinianum (*Walt.*) *Britton*
Liparis loeselii (*L.*) *Richards.*
Lobelia kalmii *Linn.*

Lonicera hirsuta *Eaton*
" sempervirens *Linn.*
Lychnis flos-cuculi *Linn.*
Lycopus rubellus *Moench.*
Lygodium palmatum (*Bernh.*) *Sw.*
Lysimachia nummularia *Linn.*

Mariscus mariscoides (*Muhl.*) *Kuntze*
Meibonia bracteata (*Mx.*) *Kuntze*
" canadensis (*L.*) *Kuntze*
" dillenii (*Darl.*) *Kuntze*
" grandiflora (*Walt.*) *Kuntze*
" michauxii *Vail*
" obtusa (*Muhl.*) *Vail*
" paniculata (*L.*) *Kuntze*
" rigida (*Ell.*) *Kuntze*
Mentha canadensis *Linn.*
Mikania scandens (*L.*) *Willd.*
Mimulus ringens *Linn.*
Mitella diphylla *Linn.*
" nuda *Linn.*
Monarda clinopodia *Linn.*
Moneses uniflora (*L.*) *A. Gray*
Muhlenbergia racemosa (*Mx.*) *B. S. P.*

Nabulus trifoliatus *Cass*
Naias marina *Linn.*
Naumbergia thrysiflora (*L.*) *Duby.*
Norta altissima (*L.*) *Britton*

Ophioglossum vulgatum *Linn.*

Panicularia canadensis (*Mx.*) *Kuntze*
" obtusa (*Muhl.*) *Kuntze*
" torreyana (*Spreng.*) *Merrill*
Panicum addisonii *Nash*
" boreale *Nash*
" capillare *Linn.*
" clandestinum *Linn.*
" columbianum *Scribn.*
" dichotomum *Linn.*
" dichotomiflorum *Michx.*
" huachucae *Ashe*
" implicatum *Scribn.*
" latifolium *Linn.*
" linearifolium *Scribn.*
" philadelphicum *Bernh.*
Panicum sphaerocarpon *Ell.*
" spretum *Schult.*
" tsugatorum *Nash*
" verrucosum *Muhl.*
" villosissimum *Nash*
" xanthophysum *A. Gray*
Parnassia caroliniana *Walt.*
Pedicularis canadensis *Linn.*
Pentstemon pentstemon (*L.*) *Britt.*
Persicaria lapathifolia (*L.*) *S. F. Gray*
" muhlenbergii (*S. Wats.*) *Small*
" pennsylvanica (*L.*) *Small*
Phalaris arundinacea *Linn.*
Philotria canadensis (*Michx.*) *Britton*
Phragmites phragmites (*L.*) *Karst*
Pilea pumila (*L.*) *A. Gray*
Plantago rugelii *Decne.*
Pluchea camphorata (*L.*) *DC.*
Poa alsodes *A. Gray*
" nemoralis *Linn.*
" triflora *Gilib.*
Polemonium van-bruntiae *Britton*
Polygala nuttallii *T. & G.*
" pauciflora *Willd.*
" verticillata *Linn.*
" viridescens *Linn.*
Polygonum sagittatum *Linn.*
" tenue *Michx.*
Potamogeton amplifolius *Tuckerm.*
Potentilla simplex *Michx.*
Poterium sanguisorba *Linn.*
Ptilimnium capillaceum (*Mx.*) *Raf.*
Pyrola americana *Sweet*
" elliptica *Linn.*
" secunda *Linn.*
" uliginosa *Torrey*

Radicula palustris (*L.*) *Moench.*
Robinia viscosa *Vent.*
Rosa canina *Linn.*
" carolina *Linn.*
Rubus procumbens *Muhl.*
Rudbeckia triloba *Linn.*
Rynchospora fusca (*L.*) *Ait.*

Sabbatia stellaris *Pursh*
Salicornia europea *Linn.*
Sanguisorba canadensis *Linn.*
Sanicula canadensis *Linn.*
" gregaria *Bicknell*
" marylandica *Linn.*
Schizachyrium scoparium (*Mx.*) *Nash*
Scirpus americanus *Pers.*
" robustus *Pursh*
Scrophularia leporella *Bicknell*
Scutellaria lateriflora *Linn.*
Selaginella rupestris (*L.*) *Spring.*
Sericocarpus asteroides (*L.*) *B. S. P.*
Sibbaldiopsis tridentata (*Soland*) *Rydb.*
Silene latifolia (*Mill.*) *B. & R.*
Solidago flexicaulis *Linn.*
" hispida *Muhl.*
" juncea *Ait.*
" puberula *Nutt.*
" rugosa *Mill.*
" sempervirens *Linn.*
Sparganium acaule (*Beeby*) *Rydb.*
" androcladium (*Engelm.*) *Morong.*
Spartina cynosuroides (*L.*) *Roth*
" michauxiana *Hitchc.*
" patens (*Ait.*) *Muhl.*
Spergula arvensis *Linn.*
Spiraea latifolia (*Ait.*) *Borkh.*
Streptopus roseus *Michx.*
Strophostyles helvola (*L.*) *Britt.*
Syntherisma sanguinale (*L.*) *Dulac.*

Taenidia integerrima (*L.*) *Drude*
Teucrium littorale *Bicknell*
" occidentale *A. Gray*
Tiarella cordifolia *Linn.*
Triosteum aurantiacum *Bicknell*
Tovara virginiana (*L.*) *Raf.*

Utricularia macrorhiza *LeConte*
Uvularia sessilifolia *Linn.*

Vaccinium canadense *Kalm*
Veronica scutellata *Linn.*
Viburnum opulus *Linn.*
Viola canadensis *Linn.*
" conspersa *Reichenb.*
" eriocarpa *Schw.*
" fimbriatula *J. E. Sm.*
" incognita *Brainerd*
" latiuscula *Greene*
" rostrata *Pursh*
" rotundifolia *Michx.*
" selkirkii *Pursh*
" septentrionalis *Greene*
" sororia *Willd.*
" subvestita *Greene*

Xanthium echinatum *Murr.*

Zanthoxylum americanum *Mill.*

CONTRIBUTORS AND THEIR CONTRIBUTIONS

Frank H. Ames, Brooklyn

Amsonia amsonia (*L.*) *Britton*

Prof. J. C. Arthur, Lafayette, Ind.

Caeoma strobilinum *Arthur*

M. S. Baxter, Rochester

Antennaria ambigens (*Greene*) *Fernald*
" canadensis *Greene*
" fallax *Greene*
" grandis (*Fernald*) *House*
" neglecta *Greene*
" neodioica *Greene*
" occidentalis *Greene*
" petaloidea *Fernald*
" parlinii *Fernald*
" plantaginifolia (*L.*) *Richard*
Aristida oligantha *Michx.*
Chaenorrhinum minus (*L.*) *Lange*
Chamaesyce glyptosperma (*Engelm.*) *Small*
Galeopsis ladanum *var.* latifolia *Wallr.*
Naias marina *Linn.*
Pyrola uliginosa *Torrey*
Selaginella rupestris (*L.*) *Spring.*
Sericocarpus asteroides (*L.*) *B. S. P.*

H. R. Bristol, Plattsburg

Peridermium comptoniae (*Britton*) *Orton & Adams*

S. H. Burnham, Hudson Falls

Aleurodiscus farlowi *Burt*
Stereum leveillianum *B. & C.*

Miss M. C. Burns, Middleville

Geaster triplex *Junghuhn*
Lychnis flos-cuculi *Linn.*

E. A. Burt, St Louis, Mo.

Craterellus ochrosporus *Burt*
" odoratus (*Schw.*) *Fr.*
Thelephora caryophyllea *Schaeff.*
" cuticularis *Berk.*
" intybacea *Pers.*
Thelephora spiculosa *Fr.*
" scissilis *Burt*
" terrestris *Ehrh.*
" vialis *Schw.*

Mrs E. P. Gardner, Canandaigua

Crepis biennis *Linn.*
Jeffersonia diphylla (*L.*) *Pers.*

J. J. Davis, Madison, Wis.

Aecidium ceanothi *Ell. & Kell.*
" euphorbiae *Gmel.*
" falcatae *Arthur*
" hydnoideum *B. & C.*
" laricis *Kleb.*
" liatridis *Ell. & And.*
Aecidium lupini *Peck*
" nesaeae *Gerard*
" proserpinaceae *B. & C.*
" pustulatum *Curt.*
" rhamni *Gmel.*

Albugo candida (*Pers.*) *Kuntze*
" tragopogonis (*DC.*) *S. F. Gray*
Ascochyta lophanthi *Davis*
Asterina rubicola *E. & E.*

Burrillia pustulata *Setch.*

Cercospora althaeina *Sacc. var.* praecincta *Davis*
" apocyni *E. & K.*
" boehmeriae *Peck*
" callae *Peck*
" caricina *Ell. & Dearn.*
" ceanothi *Kell. & Sw.*
" cercidicola *Ellis*
" comandrae *Ell. & Dearn.*
" condensata *Ell. & Kell.*
" dioscoreae *E. & M.*
" echinocystis *E. & M.*
" effusa (*B. & C.*) *E. & E.*
" fingens *Davis*
" gayophyti *E. & E.*
" geranii *Kell. & Sw.*
" gerardiae *Ell. & Dearn.*
" granuliformis *Ell. & Holw.*
" gymnocladi *Ell. & Kell.*
" negundinis *E. & E.*
" megalopotanica *Speg.*
" omphacodes *Ell. & Holw.*
" passaloroides *Wint.*
" perfoliata *E. & E.*
" physalidis *Ellis*
" pyri *Farlow*
" racemosa *Ell. & Mart.*
" rhamni *Fckl.*
" rhoina *C. & E.*
" ribicola *E. & E.*
" sagittariae *Ell. & Kell.*
" sequoiae *var.* juniperi *E. & E.*
" sii *E. & E.*
" stomatica *Ell. & Davis*
" zebrina *Pass.*
Cercosporella apocyni *Ell. & Kell.*
Cintractia subinclusa (*Koern.*) *Magn.*
Coleosporium sonchi-arvensis (*Pers.*) *Lev.*
" viburni *Arthur*

Coletotrichum graminicolum (*Ces.*) *Wilson*
Cronartium comandrae *Peck*
" comptoniae *Arthur*
" quercus (*Brondewu*) *Schroet.*
Cylindrosporium apocyni *E. & E.*
" betulae *Davis*
" clematidis *E. & E.*
" eryngii *E. & K.*
" glyceriae *E. & E.*
" negundinis *E. & E.*
" ribis *Davis*
" shepherdiae *Sacc.*
" vermiforme *Davis*

Doassansia ranunculina *Davis*
" sagittariae (*West.*) *Fisch.*

Entyloma compositarum *Farlow*
" floerkeae *Holway*
" lineatum (*Cooke*) *Davis.*
" menispermi *Farlow & Trelease*
" microsporum (*Ung.*) *Schroet.*
" nymphaeae (*Cunn.*) *Setch.*
" ranunculi (*Bon.*) *Schroet.*
" thalictri *Schroet.*
Erysiphe cichoracearum *DC.*
Exoascus betulinus (*Rostr.*) *Sadeb.*
" communis *Sadeb.*
" insitiae *Sadeb.*

Fabraea rousseauana *Sacc. & Bomm.*
Fusarium heterosporum *Nees*
Fusicladium radiosum *var.* microscopicum (*Sacc.*) *Allesch.*

Gloeosporium aridum *Ell. & Holw.*
" betularum *Ell. & Mart.*
" caryae *Ell. & Dearn.*
" confluens *Ell. & Dearn.*
" cylindrospermum (*Bon.*) *Sacc.*
" robergii *Desm.*
" saccharinum *E. & E.*
" septorioides *Sacc.*
" thalictri *Davis*
" trifolii *Peck*

Gymnosporangium clavariaeforme (*Jacq.*) *DC.*
" clavipes *C. & P.*
" davisii *Kern*
" globosum *Farlow*
" juvenescens *Kern*

Keithia thujina *Durand*
" tsugae *Farlow*
Kuehneola uredinis (*Lk.*) *Arthur*

Leptothyrium periclymeni *Desm. var.* americanum *E. & E.*

Marsonia coronariae *Sacc. & Dearn.*
" fraxini *Ell. & Davis*
" marini (*S. & E.*) *Magn.*
" neilliae (*Harkness*) *Magn.*
" potentillae (*Desm.*) *Magn.*
" violae (*Pass.*) *Magn.*
Melampsora medusae *Thüm.*
Melampsoropsis ledi (*Lk.*) *Arthur*
" ledicola (*Peck*) *Arthur*
Microsphaera alni (*Wallr.*) *Wint.*

Ovularia asperifolii *Sacc. var.* lappulae *Davis*
" destructiva (*Phil. & Plowr.*) *Massee*

Peridermium balsamium *Peck*
Peronospora grisea *Ung.*
" hydrophylli *Waite*
" leptosperma *DeBary*
" lophanthi *Farlow*
" polygoni *Thüm.*
" rubi *Rabenh.*
" trifoliorum *DeBary*
" viciae (*Berk.*) *DeBary, var.* americana *Davis*
Phleospora celtidis *Ell. & Mart.*
" ulmi (*Fr.*) *Wallr.*
Phragmidium occidentale *Arthur*
Phyllachora wittrockii (*Erikss.*) *Sacc.*
Phyllosticta destruens *Desm.*
" innumerabilis *Peck.*
" simillispora *Ell. & Davis*
Physalospora ambrosiae *E. & E.*
Phytophthora thalictri *Wils. & Davis*

Piricularia parasitica *E. & E.*
Plasmopara australis (*Spreg.*) *Swingle*
" halstedii (*Farl.*) *Berl. & DeToni*
" humuli *Miyabe & Takahashi*
" ribicola *Schroet.*
" viburni *Peck*
Protomyces andinus *Speg.*
Puccinia andropogonis *Schw.*
" balsamorhizae *Peck*
" bullata (*Pers.*) *Wint.*
" cirsii *Lasch*
" convolvuli (*Pers.*) *Cast.*
" coronata *Cda.*
" curtipes *Howe*
" cyperi *Arthur*
" dayi *Clinton*
" dulichii *Sydow*
" eatoniae *Arthur*
" eleocharidis *Arthur*
" emaculata *Schw.*
" giganthispora *Bubak*
" heucherae (*Schw.*) *Dietel*
" impatientis *Arthur*
" mesomegala *B. & C.*
" milii *Erikss.*
" ornata *Arthur & Holw.*
" panici *Dietel*
" perminuta *Arthur*
" physalidis *Peck*
" poculiformis (Jacq.) Wettstat.
" polygalae *Paschke*
" proserpinaceae *Farlow*
" pustulata *Arthur*
" pygmaea *Erikss.*
" rubifaciens *Johans.*
" sessilis *Schw.*
" seymouriana *Arthur*
" silphii *Schw.*
" simillima *Arthur*
" tomipara *Trelease*
Pucciniastrum agrimoniae (*Schw.*) *Tranz.*
" articum (*Lagh.*) *Tranz. var* americanum *Farl.*

Ramularia brunellae *E. & E.*
" lysimachiae *Thüm.*
" nemopanthis *C. & P.*
" occidentalis *E. & K.*
" plantaginis *E. & M.*
" prini *Peck*
" punctiformis (*Schl.*) *var. Hoehn.*
" reticulata *E. & E.*
" rosea (*Fckl.*) *Sacc.*
" smilacinae *Davis*
" spiraeae *Peck*
" stolonifera *E. & E.*
" uredinis (*Voss*) *Sacc.*
" virgaureae *Thüm.*
Rhytisma andromedae (*Pers.*) *Fr.*

Sclerotium bifrons *E. & E.*
" globuliferum *Davis*
Septogloeum ampelopsidis *E. & E.*
" nuttalii *Harkness*
Septoria acerella *Sacc.*
" alnifolia *E. & E.*
" asclepiadicola *E. & E.*
" astericola *E. & E.*
" atropurpurea *Peck*
" brevispora *E. & Davis*
" cephalanthi *E. & K.*
" cerastii *Rob. & Desm.*
" cornicola *Desm.*
" davisii *Sacc.*
" dimera *Sacc.*
" helenii *E. & E.*
" lophanthi *Wint.*
" ludwigiae *Cooke*
" lythrina *Peck*
" menyanthis *Desm.*
" musiva *Peck*
" nubilosa *E. & E.*
" pachyspora *Ell. & Holw.*
" physostegiae *E. & E.*
" prenanthis *E. & E.*

Septoria
" polymniae *E. & E.*
" rumicis *Ellis*
" salicifoliae (*Trel.*) *Berl. & DeToni*
" sambucina *Peck*
" silphii *E. & E.*
" salicis *West.*
" solidaginicola *Peck*
" speculariae *B. & C.*
" xanthiifolia *Ell. & Kell.*
Sphaerotheca humuli (*DC.*) *Burr.*
Synchytrium aureum *Schroet.*
" scirpi *Davis*

Taphrina potentillae (*Farlow*) *Johans.*
" coryli *Nishida*

Uredinopsis atkinsonii *Magn.*
" mirabilis (*Peck*) *Magn.*
" osmundae *Magn.*
" struthiopteris *Stormer*
Urocystis agropyri (*Preuss.*) *Schroet.*
" waldsteiniae *Peck*
Uromyces acuminatus *Arthur*
" hyperici-frondosi (*Schw.*) *Arthur*
" poinsettiae *Tranz.*
" pyriformis *Cooke*
" rudbeckiae *A. & H.*
" spermacoces (*Schw.*) *Thüm.*
" trifolii-repentis (*Cast.*) *Liro.*
Urophlyctis pluriannulatum (*B. & C.*) *Farlow*
Ustilago longissima (*Sow.*) *Tul.*
" " var. macrospora *Davis*
" perennans *Rostr.*
" violacea (*Pers.*) *Fckl.*

Prof. John Dearness, London, Ont.

Ascochyta colorata *Peck*
" pisi *Lib. var.* lupini *Sacc.*

Basidiophora entospora *Roze & Cornn.*

Cercospora diffusa *E. & E.*
" zebrina *Pass.*
Cladosporium ramuosum *Desm.*
Corticum vagum *B. & C.*

Darluca bubakiana *Kabat.*

Diplodia linderae *E. & E.*
Discosia maculicola *Gerard*
Doassansia affinis *Ell. & Dearn.*
" alismatis (*Nees*) *Cornn.*
" deformans *Setch.*
" martianoffiana (*Thüm.*) *Setch.*

Entomosporium thümeni (*Cke.*) *Sacc.*
Entyloma compositarum *Farlow*
" nymphaeae (*Cornn.*) *Setch.*
" physalidis (*Kl. & Cke.*) *Wint.*

Gloeosporium canadense *E. & E.*
" caryae *Ell. & Dearn.*
" catalpae *E. & E.*
" robergei *Desm.*
" salicis *West.*
" trifolii *Peck*

Macrosporium solani *E. & M.*

Peronospora effusa (*Grev.*) *Rabenh.*
" calotheca *DeBary*
" corydalis *DeBary*
" arthuri *Farlow*
" lophanthi *Farlow*
" trifoliorum *DeBary*
Plasmopara geranii *Peck*
" halstedii (*Farl.*) *Berl. & DeToni*
Phyllosticta cruenta (*Fr.*) *Kickx.*
" lentaginis *Sacc. & Syd.*
Phyllosticta punctata *Ell. & Dearn.*
Phycotheca viticola (*B. & C.*) *Wils.*
Puccinia poarum *Niels.*

Ramularia hamamelidis *Peck*
Rhytisma ilicis-canadensis *Schw.*

Schizonella melanogramma (*DC.*) *Schroet.*
Septogloeum ampelopsidis *E. & E.*
Septoria anemones *Desm.*
" apii *Chester*
" brunneola (*Fr.*) *Niessl.*
" cornicola *Desm.*
" atropurpurea *Peck*
" consimilis *E. & M.*
" dolichospora *E. & E.*
" menyanthis *Desm.*
" polaris *Karst*
" rubi *var.* pallida *Ell. & Holw.*
" rudbeckiae *Ell. & Holw.*
" sambucina *Peck*
" stachydis *R. & D.*
Synchitrium decipiens *Farlow*

Urophylictis pulposa (*Wallr.*) *Schroet.*
Urocystis anemones (*Pers.*) *Wint.*
Ustilago longissima (*Sow.*) *Tul.*
" perennans *Rostr.*
" zeae (*Beckm.*) *Ung.*

Valsaria exasperans *Ger. var.* aceris *Rehm.*

Mrs John Dennis, Rochester

Monarda clinopodia *Linn.*

Dr W. A. Murrill, New York

Boletinus pictus *Peck*

Ceriomyces subglabripes (*Peck*) *Murrill*
Chanterel infundibuliformis (*Scop.*) *Fr.*
" umbonatus *Fr.*
Collybia dryophila *Bull.*
" maculata *A. & S.*
Collybia strictipes *Peck*
Cortinarius armillatus *Fr.*
Clitocybe clavipes (*Pers.*) *Fr.*
" sinopica *Fr.*
Clavaria pistularis *Linn.*
" pinophila *Peck*
Craterellus cornucopioides *Pers.*
Cudonia lutea (*Peck*) *Sacc.*

Fomitiporia prunicola *Murrill*

Agaricus diminutivus *Peck*

Hydnum caput-ursi (*L.*) *Fr.*

Lactaria gerardii *Peck*
" mucida *Burlingham*
" subdulcis (*Pers.*) *Fr.*
" turpis (*Wenm.*) *Fr.*
" torminosa (*Schaeff.*) *Pers.*
" ligniota *Fr.*
Lepiota amianthina (*Scop.*) *Quel.*
" clypeolaria (*Bull.*) *Quel.*
Leotia lubrica (*Scop.*) *Pers.*
Lachnea hemisphaerica (*Wiggs.*)

Marasmius confluens (*Pers.*) *Ricken.*

Melanoleuca albissima (*Peck*) *Murrill*

Omphalia chrysophylla *Fr.*

Pholiota squarrosa *Muell.*
" caperata (*Pers.*) *Fr.*

Rostkovites granulatus (*L.*) *P. Karst.*
Russula depallens (*Pers.*) *Fr.*
" compacta *Frost & Peck*
" foetens (*Pers.*) *Fr.*
" lutea (*Huds.*) *Fr.*

Spathularia velutipes *C. & F.*

Tyromyces guttulatus (*Peck*) *Murrill*

Venenarius frostianus (*Peck*) *Murrill*
" phalloides (*Fr.*) *Murrill*

C. G. Lloyd, Cincinnati, Ohio

Trametes abietis *Karst.*
Trametes piceina *Peck*

J. H. Livingston, Tivoli-on-Hudson

Phyllosticta ampelopsidis *E. & M.*

W. A. Matthews, Rochester

Dryopteris clintoniana (*D. C. Eaton*) *Dowell*
" intermedia (*Muhl.*) *A. Gray*
Dryopteris spinulosa (*Muell.*) *Kuntze*
Monarda clinopodia *Linn.*

Prof. L. H. Pennington, Syracuse

Antrodia mollis (*Sommerf.*) *Karst.*
Azolla caroliniana *Willd.*

Bactridium flavum *Kze. & Schum.*

Cercospora betacola *Sacc.*
Clavaria mucida *Pers.*
Clitopilus abortivus *B. & C.*
Cronartium comandrae *Peck*
Daedalia quercina (*L.*) *Pers.*
Chlorosplenium aeruginosum (*Oed.*) *DeNot.*

Daldinia concentrica (*Bolt.*) *Ces. & DeNot.*
Diatrype stigma (*Hoffm.*) *Fr.*

Elaphomyces variegatus *Tul.*
Elfvingia fomentaria (*L.*) *Murrill*

Fomes populinus (*Schum.*) *Cooke*
" roseus (*Alb. & Schw.*) *Cooke*
" scutellatus (*Schw.*) *Cooke*
Fomitiporella betulina *Murrill*

Gloeophyllum hirsutum (*Schaeff.*) *Murrill*
" trabeum (*Pers.*) *Murrill*
Gloeosporium caryae *E. & E.*
" nervicolum *G. Massee*
" nervisequum (*Fckl.*) *Sacc.*
Gnomonia beneta (*Sacc.*) *Kleb.*
Gymnosporangium clavariaeforme (*Jacq.*) *DC.*

Holwaya giganthea (*Peck*) *Dur.*

Hydnum schiedermayeri (*Heufler*)
Hapalopilus gilvus (*Schw.*) *Murrill*
" rutilans (*Pers.*) *Murrill*

Lenzites betulina (*L.*) *Fr.*
Leotia lubrica (*Scop.*) *Pers.*

Marssonia juglandis (*Lib.*) *Sacc.*
Massaria vomitoria *B. & C.*
Melampsorella elatina (*Alb. & Schw.*) *Arth.*
Melanconium oblongum *Berk.*

Peronospora corydalis *DeBary*
Phyllosticta hamamelidis *Peck*
" paviae *Desm.*
Plasmopara viticola (*B. & C.*) *Berl. & DeToni*
" serotinus *Schrad.*
Porodisculus pendulus (*Schw.*) *Murrill*
Pseudopeziza medicaginis (*Lib.*) *Sacc.*
Puccinia malvacearum *Mont.*
" menthae *DC.*
" mesomegala *B. & C.*
" pimpinellae *Mart.*
" podophylli *Schw.*
" suaveolens (*Pers.*) *Rostr.*

Pycnoporus cinnabarinus (*Jacq.*) *Karst.*

Rhytisma punctata (*Pers.*) *Fr.*

Schizonella melanogramma (*DC.*) *Schroet.*
Septoria apii (*B. & C.*) *Chester*
" brunellae *Ell. & Holw.*
" dentariae *Peck*
" polygonarum *Desm.*
" viridi-tingenes *Curt.*
Sphaeropsis sumache (*Schw.*) *C. & E.*
Stigmatea robertiana *Fr.*
Synchytrium decipiens *Farlow*

Taphrina caerulescens (*Desm. & Mont.*) *Tul.*
Trametes piceina *Peck*

Urocystis anemones (*Pers.*) *Wint.*
Uromyces hedysari-paniculati (*Schw.*) *Farlow*
Ustilago heufleri *Fckl.*
" lorentziana *Thüm.*
" rabenhorstiana *Keuhn.*
" residua *Clinton*
" utriculosa (*Nees*) *Tul.*

Xylaria polymorpha *Pers.*

H. C. Sands, Malone

Spongospora subterranea (*Wallr.*) *Johnson*

F. A. Ward, Cortland

Poterium sanguisorba *Linn.*

Miss E. C. Webster, Syracuse

Centaurea nigra *Linn.*
Chenopodium glaucum *Linn.*

NEW OR INTERESTING SPECIES OF FUNGI III

1 Fungi new to the State flora

Aleurodiscus farlowi Burt

On dead branches and twigs of hemlock, Tsuga canadensis, Vaughns, Washington county. S. H. Burnham, February 20, 1914. (Determined by E. A. Burt.)

Botryosphaeria fuliginosa M. & M.

On dead twigs of Fraxinus americana L., Sylvan Beach, Oneida county. H. D. House, May 14, 1915.

Calosphaeria cornicola E. & E.

On dead branches of Cornus paniculata near Bethlehem, N. Y. April. Dr Charles H. Peck.

Cercospora caricis Dearness & House, n. sp.

Spots yellow, not definitely bordered, similar on both sides of the leaf, generally following but not bounded by the veinlets; hyphal tufts brown, hyphae 15–20 by 4–6 μ, amphigenous but mostly epiphyllous; conidia hyaline, slightly obclavate, occasionally concatenate, flexuous, continuous to 4-septate, 40–80 by 3 μ.

Old Forge, N. Y., on leaves of Carex folliculata. Dr C. H. Peck, August.

This species differs very markedly from Cercospora caricina Ell. & Dearness, which has minute hypophyllous tufts, and from Cercospora microstigma Sacc., which possesses smoky, margined spots.

Coniothyrium concentricum Desm.

On languishing leaves of Yucca filamentosa L. (cultv.) Oneida, Madison county. H. D. House, June 20, 1915.

Coryneum umbonatum Nees

On dead twigs of Carpinus caroliniana Walt. Sylvan Beach. H. D. House, May 10, 1915.

Cucurbitaria ceanothi Dearness & House, sp. nov.

Perithecia rough, small, subcaespitose on a black cortical stroma which finally throws off the cuticle; asci paraphysate, 150–175 by

10–15 μ; sporidia evenly to obliquely uniseriate, 3–7 but mostly 5–6 septate, 20–26 by 11–12 μ, somewhat constricted at the middle septum.

On dead stems of Ceanothus americanus. Albany. H. D. House, November to April. Type in the herbarium of the New York State Museum.

Cyphella conglobata Burt

(Ann. Mo. Bot. Gard. 1:375. 1914)

Adirondack mountains and North Elba. Collected by Dr C. H. Peck. (Determined by E. A. Burt.)

Dendrophoma albomaculans (Schw.) Starb.

On dead branches of Lilac (Syringa vulgaris L.), Rensselaer. H. D. House, June 9, 1915.

Diaporthe ailanthi Sacc. var. **viburni** Dearness & House, var. nov.

On dead twigs of Viburnum dentatum L. Sylvan Beach, Oneida county, N. Y. H. D. House, May 13, 1915.

The largest perithecia are about 360 μ in diameter, the asci are 45–60 x 6–9 μ and the 4-nucleate sporidia are 11–15 x 3–3½ μ. The only difference between this and the typical form of the species occurring on Ailanthus is that here the sporidia are not constricted, while in D. Ailanthi they are said to be slightly constricted.

Diaporthe comptoniae (Schw.) E. & E.

On dead twigs of Comptonia peregrina (L.) Coulter. Near Albany, N. Y. H. D. House, July 19, 1915.

Diaporthe minuta Dearness & House, sp. nov.

Perithecia minute, .3 mm; thickly scattered, the black entire ostiola scarcely visible above the ruptured cuticle, flesh white; asci fusoid, short-stipitate, 75 by 6–7 μ, profusely paraphysate, paraphyses linear and longer than the asci; sporidia uniseptate, somewhat constricted, hyaline, nucleate, acute at each end, 15 by 3 μ.

On dead stems of Ceanothus americanus Linn. Albany. H. D. House, March, 1915. Type in the herbarium of the New York State Museum.

Cercospora lathyri Dearness & House, sp. nov.

Spots bluish gray, becoming darkened with age, many of them finally arid, bounded by a narrow reddish border limited by the veinlets, 2–4 x 2–3 mm; hyphae very short on numerous evenly scattered brownish bases, amphigenous; conidia mostly epiphyllous,

continuous, or obscurely one to few septate, straight or slightly curved, amphigenous, 40–70 x 2¾–3¼ μ, mostly about 45 μ long.

On living and languishing leaves of the beach pea (Lathyrus maritimus (L.) Bigel.), Wading River (type) and Eastport, N. Y. Charles H. Peck. August and September. (Year not indicated on the collection). Type in the herbarium of the New York State Museum.

Diaporthe tecta (Cooke) Sacc.

(Valsa tecta *Cooke*)

Sand's point, Long Island, on dead twigs of Myrica carolinensis Mill. H. D. House, September 8, 1915. Professor Dearness, who examined these specimens, states that Cooke does not mention that the sporidia are appendiculate; otherwise the description agrees with the specimens.

The species is based upon Ravenel's. N. Am. F. no. 747. J. B. Ellis redescribed the species from a copy of no. 747, and states that the discrepancy (in part) between the two descriptions is remarkable. Cooke & Ellis may have had two different species in hand.

The same collection contains a little Calosphaera myricae C. & E.

Diaporthe tuberculosa (Ell.) Sacc. var. **pruni** Dearness & House, var. nov.

The perithecia, asci and sporidia are quite similar to those of the typical form of this species on Amelanchier, although the perithecia penetrate to or slightly into the wood on this host. The black stromatic boundary also penetrates more deeply and rises distinctly to the surface of the bark, elevating it into a narrow blackened circular ridge with a diameter of from 2 to 5 mm.

On dead twigs of Prunus serotina Ehrh. Oneida, Madison county, N. Y. H. D. House, May 15, 1915.

Didymosphaeria empetri (Fr.) Sacc.

On dead leaves of Empetrum nigrum L. Mount Marcy. H. D. House, July 1913.

Didymosphaeria housei Dearness

(Mycologia 8:100. 1916)

Perithecia scattered, dark, raising the cuticle in small pustules, .3 mm; ostiola very short, almost obsolete; asci paraphysate, cylindrical, short stipitate, 60–72 by 5–6 μ; sporidia smoky brown, 1-septate, slightly constricted, compactly uniseriate, 8–9 by 4–4½ μ.

On dead twigs of Ceanothus americanus Linn. Albany. H. D. House, January to April 1915. Type in the herbarium of the New York State Museum. Resembling Didymosphaeria ceanothi Cooke & Harkness of California, but the spores much smaller.

Microdiplodia ceanothi Dearness & House, sp. nov.

Acervuli scattered, raising the cuticle which is blackened into small pustules, ⅓ to ½ mm broad; spores smoky brown, suboblong, 9–11 by 4–5 μ.

On dead twigs of Ceanothus americanus Linn. Albany. H. D. House, March 1915. Type in the herbarium of the New York State Museum. Probably a stage of Didymosphaeria housei Dearness, which was found upon the same twigs.

Diplodia microspora B. & C.

On Viburnum dentatum Linn. Albany, N. Y. Collected by H. D. House, May 1915.

There is nothing in the meager description of Diplodia microspora to exclude our material except that the conidia of the latter are rather uniformly 9 x 3–3½ μ instead of 6–7 x 3 μ as given in the description by Saccardo. The type of D. microspora was collected by Curtis on Viburnum opulifolium (V. Opulus).

Eichleriella leveilliana (B. & C.) Burt

(Stereum leveillianum *B. & C.*)

On dead branches and twigs of hemlock, Tsuga canadensis (L.) Carr. Vaughns, Washington county. S. H. Burnham, February 20, 1914. (Determined by E. A. Burt.)

Flammula penetrans Fr.

On decayed pine logs, Sylvan Beach, Oneida county. H. D. House, October 12, 1915.

Gloeosporium alnicola Dearness & House, sp. n.

Spots subcircular, reddish brown with a diffused darker border, 1 cm in diameter; acervuli amphigenous, concolorous or usually darker, depressed, 50–150 μ, mostly about 70 μ; conidia continuous, elliptic-oblong, 9–12 by 2.75–3 μ.

On living leaves of Alnus rugosa (DuRoi) K. Koch. Eastport, Long Island. Dr C. H. Peck, August.

Gloeosporium falcatum Dearness & House, sp. nov.

Spots gray with a darker, ridged border and surrounded by an indefinite, reddish, somewhat translucent margin, 3 to .7 mm broad. Acervuli epiphyllous, concolorous, scattered, best observed with reflected light under the microscope, 90–150 μ. Spores falcate, hyaline, acute at one or both ends, grumous and guttulate, 24–32 x 8–12 μ.

On living leaves of Benzoin aestivale (L.) Nees. Black lake near Catskill, N. Y. H. D. House, August 21, 1915. Type in the herbarium of the New York State Museum.

The specimens are perhaps rather immature and might possibly develop septa in the spores, in which case it would be a Marsonia related to M. daphnes.

Gloeosporium hydrophylli Dearness & House, sp. nov.

Spots slaty gray, subcircular when not marginal, mostly about 1 cm broad, concentrically ridged when seen through a lens, becoming dry and brittle and breaking up.

Acervuli innate, often found in sections where their positions were not discovered with the lens. Spores hyaline, 5–9 x 2–2½ μ, nucleate at each end.

On living leaves of Hydrophyllum canadense L. Green lake near Kirkville, Onondaga county. H. D. House, August 1915. Type in the herbarium of the New York State Museum.

Ascochyta wisconsina Davis

Near Cicero, Onondaga county, on living leaves of Sambucus canadensis L. H. D. House, August 10, 1915. The fungus at first suggested a species of Gloeosporium but Professor Dearness, who identifies the species, notes that spores were found with a hyaline septum and that there is a thin pycnidial wall. The zonation, colors and spore measurements agree with the description of Ascochyta wisconsina, and differs from A. ebuli Fckl. described on Sambucus in Europe.

Leptonia euchlora (Lasch) Quel.

(Sacc. Syll. 5:713. 1887)

Pileus submembranaceous, campanulate becoming deeply depressed in the center, yellowish green or brownish when young becoming brownish with age, the surface radiately furrowed and streaked with paler tints, minutely tawny fibrillose and roughened

but scarcely squamulose, the margin irregular, 1–4 cm broad; flesh very thin and pallid; stipe slender, 2–4 cm long, 2.5–5 mm thick, hollow, grass green but the flesh pallid, surface becoming somewhat fuscus with age and slightly fibrillose; lamellae adnate and decurrent, rather distant, pallid or slightly yellowish when young, soon becoming flesh-colored; spores pale rusty brown in mass, angular, 9–13 x 5–9 μ.

Damp clay soil in deciduous thickets. Green lake near Kirkville, Onondaga county. H. D. House, *no. 14.16,* June 6, 1914. Orville, Onondaga county. George E. Morris, August 13, 1910.

Identification of this interesting species was suggested by Mr Morris and further examination of the specimens and notes makes the identification almost positive, and adds another species, heretofore known only in Europe, to the fungus flora of America.

The bright green stipe is so characteristic that the species can scarcely be mistaken. The two localities mentioned are about eight miles distant from each other.

Leptosphaeria triglochinis Schrt.

On dead stems of Triglochin palustre L. Castle swamp, Oneida, Madison county. H. D. House, June 20, 1915.

Leptosphaeria hydrophila Sacc.

Oneida, N. Y. on Typha angustifolia L. July 19, 1913. Determined by Saccardo. Originally described as found on Juncus effusus in Italy and not previously collected in America, nor upon this host.

Macrophoma viburni Dearness & House, sp. nov.

Pycnidia thickly scattered, nearly black, perforate, 125–270 μ in diameter. Conidia hyaline, naviculate, 19–25 x 6 μ, on evident short basidia.

Associated with a Rhabdospora on dead twigs of Viburnum opulus L. Catskill, N. Y. H. D. House, August 22, 1915. Type in the herbarium of the New York State Museum.

Metasphaeria staphyleae Dearness & House, sp. nov.

Perithecia scattered, raising the epidermis into flat, pale, perforated pustules, lenticular to subglobose, 180–360 μ; ostiola cylindric, obtuse and short.

Asci clavate-cylindrical, often widest near the middle,

75–90 x 8–15 μ, sometimes stipitate; paraphyses obscure, almost lacking among the older asci and then suggesting a Sphaerulina, but evident among the undeveloped asci.

Sporidia hyaline, elliptic, tri-septate, irregularly uniseriate, often biseriate near the middle or at the apex of the ascus, variable in size, 15–22 x 5–8 μ.

On dead twigs of Staphylea trifoliata L. West Park, Ulster county, N. Y. H. D. House, May 6, 1915. Also collected on the same host at Green pond, near Jamesville, Onondaga county, May 11, 1915. Type in the herbarium of the New York State Museum.

Metasphaeria staphylina (Pk.) Sacc. proves to be, upon examination of the type material, a species of Hysterium and is redescribed in another place.

Metasphaeria varia Dearness & House, sp. nov.

Perithecia thickly scattered, ½ mm apart or crowded, seated in the cortex and producing a black stain on the surface of the wood, rupturing and raising the cuticle into pustules about .3 mm in diameter, depressed globose with short very variable ostiola, in section white with a dark border.

Asci sparsely paraphysate but covered by a brownish layer of apparently paraphysal origin, adhering as though in a mucilaginous matrix and separable with difficulty, clavate, thick-walled, 75–100 μ.

Sporidia hyaline, biseriate, constricted, upper half larger, sometimes separating at the constriction, very variable in size from 15 x 3 μ to 27 x 7 μ or even 33 x 6 μ, and in septation 3–8 septate, quite frequently 4 septate in the upper half and 3 septate in the lower one, occasionally longitudinally septate between two septa.

On dead branches of Rhus copallina L. North Bay, Oneida county. H. D. House, June 22, 1915. Type in the herbarium of the New York State Museum.

Massaria plumigera E. & E.

var. **tetraspora** Dearness & House, var. nov.

Sporidia variable but larger than those of the type, the largest measuring 82 x 21 μ; asci 4-spored, 125–165 x 32–40 μ; paraphyses filiform and longer than the asci. As in the type the sporidia are permanently hyaline.

On dead twigs of Viburnum dentatum Linn. Albany, N. Y. Collected by H. D. House, May–June, 1915. Type in the

herbarium of the New York State Museum. Also collected on same host at Sylvan Beach, Oneida county, May 13, 1915.

Comparison of this collection with that made by Doctor Peck in 1877 on Viburnum lentago (31st Rep't, p. 50. 1879 as Massaria gigaspora Fckl.) shows them to be the same. The herbarium name of the specimens upon which this report was made was later changed by Doctor Peck to Massaria corni (Fr. & Mont.), which also inhabits Viburnum but its sporidia are brown and in globose-depressed perithecia. They differ from M. gigaspora Fckl. which is said to bear eight spores, four in an upper and four in a lower division of the ascus, and to have paraphyses shorter than the asci.

Microdiplodia lophiostomoides Dearness & House, sp. nov.

Pycnidia thinly scattered, when well developed rising through the closely investing elongate clefts in the bark, and strongly resembling a Lophiostoma, 1 x .25 mm.

Conidia brown, innumerable, uni-septate, guttate in each cell, oblong-elliptic, sometimes constricted, 11–13 x 5–7 μ, mostly about 12 μ long, on basidia often half their length.

On dead twigs of Liriodendron tulipifera L. Oneida, Madison county, N. Y. H. D. House, May 15, 1915. Type in the herbarium of the New York State Museum.

With one or two out of several sections there was found a Leptosphaeria with very minute perithecia, asci 40–45 x 8 μ, amber sporidia 15 x 4 μ, 3–septate, second cell largest. This might be supposed to be L. stictoides only that this species is said to have 5–septate sporidia.

Pestalozzia flagellifera E. & E.

On dead twigs of Comptonia peregrina (L.) Coulter. Near Albany, N. Y. H. D. House, July 19, 1915.

Phoma florida Dearness & House, sp. nov.

Pycnidia minute, .1 mm densely gregarious, subcuticular, causing ashen spots or stripes on the smooth, pale-brown twigs. Conidia sessile or nearly so, hyaline, 9 x 3 μ, rounded at the ends, mostly narrowed at one end.

On dead twigs of Cornus florida L. Yonkers, N. Y. H. D. House, May 8, 1915.

Phoma ailanthi Saccardo.

On dead shoots of Ailanthus glandulosus Desf. Yonkers. H. D. House, May 8, 1915. Albany. H. D. House, June 10, 1915.

Phoma imperialis Sacc. & Roum.

(Phoma paulowniae *Sacc.* not *Thüm.*)

On twigs of Paulownia tomentosa (Thunb.) Baill. Yonkers, N. Y. H. D. House, May 8, 1915.

The typical species inhabits petioles of Paulownia imperialis in France. The description in the Sylloge is rather meager to establish positively the identity of the Yonkers material, but for the nonessential fact that the former was on petioles while ours inhabits twigs, there is no difference so far as the description of the type goes. The following description is drawn from the Yonkers material.

Pycnidia immersed in the thin bark, mostly elliptic, 1 x .25–.3 mm, flat, dark brown or black and showing through the epidermis which is pierced by the short conic stomata; conidia abundant, hyaline, somewhat acutely elliptic, nucleate, 6–9 x 3 μ on basidia of about their own length.

Phoma paulowniae Thüm. is quite distinct.

Phoma linariae Dearness & House, sp. nov.

Pycnidia dark brown, very numerous, flat to subglobose or depressed around the small central stomata which pierce the cuticle, 150–200 μ in diameter; conidia numerous, hyaline, oblong to somewhat curved, 2–3 x 1 μ.

On dead stems of Linaria vulgaris Mill. Albany, N. Y. H. D. House, May 23, 1915.

Phoma longipes B. & C.

Orient Point, Long Island. On Morus alba L. Roy Latham, May 1, 1911. Reported as Phoma moricola Sacc. by Burnham and Latham in Torreya 14:210. 1914.

Phoma pectinata Dearness & House, sp. nov.

Pycnidia strictly hypophyllous, flat-globose to conic-globose, black, minutely perforate, stellately or cleftwise rupturing the raised cuticle, disposed in linear ranks, a few to about 20 on each side of the midvein, .25–.35 mm.

Conidia hyaline, ovoid to subglobose, 12–14 x 9–10 μ, on narrow sporophores, sometimes of their own length or longer.

On leaves of Abies pectinata on limbs which have died without casting their leaves. Oneida, Madison county, N. Y. H. D. House, May 14, 1915. Type in the herbarium of the New York State Museum.

Phoma platanicola Dearness & House, sp. nov.

Pycnidia rather sparsely scattered, raising the ruptured cuticle, pale, flat, circular, pseudo-locellate, .3–.5 mm. Conidia hyaline, non-guttulate, elliptic to subfusoid, 9–12 x 4–6 μ, on sporophores of the same length as the conidia, some of which are branched.

On dead twigs of Platanus occidentalis L. Sylvan Beach, Oneida county. H. D. House, June 21, 1915. Type in the herbarium of the New York State Museum. This comes near Phoma almeidae Sacc. & Trav., the conidia and sporophores of which are narrower and of different shape.

Phyllosticta ambrosioides Thüm.

On living leaves of Chenopodium ambrosioides L. Syracuse, N. Y. H. D. House, August 1915.

Phyllosticta staphyleae Dearness

On "blighted" capsules of Staphylea trifoliata L. near Black lake, north of Leeds, Greene county. H. D. House, August 21, 1915.

Phyllosticta myricae Cooke

On living and languishing leaves of Myrica carolinensis Mill. Sand's point, Long Island. H. D. House, September 8, 1915.

Phyllosticta steironematis Dearness & House, sp. nov.

Spots reddish, scattered, circular, 2–3 mm broad or confluent and extending over half or the whole of the leaf. Pycnidia amphigenous, black, 75–150 μ, not deeply seated. Conidia hyaline, globose, grumous, 5–6 μ.

On living leaves of Steironema ciliatum (L.) Raf. North Greenbush, N. Y. H. D. House, July 20, 1915. Type in the herbarium of the New York State Museum. The spores of this species are very distinct from those of either P. dodecathei Trelease or P. lysimachiae Allesch.

Puccinia conii (Strauss) Fuckel, II, III.

On leaves of Conium maculatum L. Eastport, Long Island. Collected by Dr C. H. Peck, August.

Ramularia cichorii Dearness & House, n. sp.

Spots scattered, small, grayish brown, alike on both sides of the leaf, bounded by usually 2 or 3 concentric ridges, 2–3 mm in diameter; tufts epiphyllous, minute, scarcely visible in the absence of sporules; conidia hyaline, not numerous on the tufts, even, continuous, 15–22 x 2¾ μ.

On living leaves of Cichorium intybus L. Evans Mills, N. Y. July. Collected by Dr C. H. Peck.

Scolescosporium coryli Dearness & House, n. sp.

Spots arid, definitely narrow bordered, 2–3 mm broad; acervuli epiphyllous, brown, irregular on the veinlets, hemispherical on the flat surface of the leaf, 100–150 μ; conidia four-celled, apical cell hyaline, somewhat elongate, subacute, others smoky brown, the basal one rounded; some of the spores curved, 12 x 5 μ.

On languishing leaves of Corylus americana Walt. Coleman's, N. Y. Collected by Dr C. H. Peck, October 3, 1908.

Septoria cryptotaeniae Ell. & Rau

On leaves of Deringa canadensis (L.) Kuntze. Fonda. Collected by Dr C. H. Peck, June.

Septoria mollisia Dearness & House, n. sp.

The affected part of the leaf, often the whole leaf, sordid or dull brown; pycnidia epiphyllous, waxy brown, punctate, very numerous, evenly scattered, 50–150 μ in diameter, widely open, saucerlike, suggesting Mollisia or Belonopsis; sporules straight, continuous, long and very narrow, 35–65 (mostly 60) by .5–.75 μ.

On leaves of Antennaria neodioica Greene and A. canadensis Greene, collected by M. S. Baxter near Greece, Monroe county, N. Y., May 1913. This species differs from Septoria lanariae Fairm. in lacking definite, margined spots and having longer, narrower sporules.

It may be questioned whether the waxy appearing rim is a part of a true pycnidial wall and whether the plant should not be called a Cylindrosporium.

Septoria pentstemonis E. & E.

On living leaves of P e n t s t e m o n l a e v i g a t u s Ait. near Catskill, N. Y. H. D. House, August 21, 1915.

Septoria tenuis Dearness & House, sp. nov.

Pycnidia epiphyllous, numerous, seriate, nearly superficial, 90 μ in diameter. Sporules continuous, 45–90 x 1–1½ μ.

On dry dead portions of leaves of C a r e x t e n u i s Rudge, and on dry portions of leaves yet green. Sylvan Beach, Oneida county, N. Y. H. D. House, May 10, 1915. Type in the herbarium of the New York State Museum.

Sphaerella ciliata E. & E.

On dead stems of S t e i r o n e m a c i l i a t a (L.) Raf. Sylvan Beach, Oneida county. H. D. House, May 13, 1915.

Sphaerella ailanthi Ell. & Barth.

On dead branches of A i l a n t h u s g l a n d u l o s a Desf. Albany, N. Y. H. D. House, February 22, 1915.

Sphaeropsis ceanothi Dearness & House, sp. nov.

Pycnidia subcuticular, raising the cuticle in globose-elliptic pustules, 200–300 μ, firm and white at first, darkening at maturity; ostiola round and merely penetrating the cuticle; spores strongly nucleate at first, finally homogeneous and brown, 20–22 by 10–11 μ, on basidia usually about half the length of the spores.

On dead stems of C e a n o t h u s a m e r i c a n u s Linn. Albany. H. D. House, January 1915. Type in the herbarium of the New York State Museum.

Sphaeropsis coryli E. & E.

On dead twigs of C o r y l u s a m e r i c a n a Marsh. Karner, Albany county. H. D. House, June 16, 1915.

Sphaeropsis parallela Dearness & House, sp. nov.

Pycnidia black, subglobose, .3 mm, minutely perforate, almost contiguous in parallel series, erumpent through elongate and finally continuous linear clefts in the cuticle. Conidia brown, pyriform but varying to subglobose, 18–30 x 12 μ, 1–3 guttate, on short basidia.

On dead branchlets of Cornus florida L. Yonkers, N. Y. H. D. House, May 8, 1915. Type in the herbarium of the New York State Museum.

Sphaeropsis viburni-dentati Dearness & House, sp. nov.

Pycnidia gregarious in the cortex, globose, 160–300 μ, raising the covering cuticle which is minutely pierced by the short black ostiola; conidia pale brown, oblong with rounded ends, 18 x 7 μ to 22 x 6½ μ, on basidia which are one-half to two-thirds of the length of the spores.

On dead stems of Viburnum dentatum Linn. Albany, N. Y. Collected by H. D. House, May–June, 1915. Type in the herbarium of the New York State Museum.

Differs from Sphaeropsis lantanae P. Brun., which has smaller dark-brown spores in erumpent, black perithecia, and from Sphaeropsis viburni Ell. & Dearness, which has larger, dark-brown, subpyriform spores and is phyllogenous.

Stagonospora convolvuli Dearness & House, sp. nov.

Spots reddish brown, irregular, .5 to 1 cm broad, deciduous, not bordered but faintly concentrically ridged on the upper side. Pycnidia mostly epiphyllous, black around the perforate mouth, 80–125 μ in diameter, obscure or imperfect beneath. Sporules hyaline, fusoid, subacute at one end, rounded at the other, nucleate, faintly 2–3 septate, 15–18 x 3–4 μ.

On living leaves of Convolvulus sepium L. Roadside north of Liverpool, Onondaga county. H. D. House, August 12, 1915. Type in the herbarium of the New York State Museum.

It was thought at first that this might be a variety of Septoria calystegiae West., but that has smaller spots and filiform conidia 30–40 x 4–5 μ. The difference between Septoria and Stagonospora is mainly that of "filiform" and "fusoid" as applied to the shape of the conidia. The specimens here considered belong clearly to the later type and hence to the genus Stagonospora. In Septoria calystegiae the pycnidia are mostly hypophyllous.

Vermicularia polygoni-virginici Schw.

On dead stems of Polygonum muhlenbergii (Meisn.) S. Wats. Sylvan Beach, Oneida county. H. D. House, May 13, 1915.

2 Notes on fungi

Asterina rubicola E. & E.

On living leaves of Rubus canadensis L. Albany. H. D. House, July 25, 1915.

Aulographum subconfluens Peck

(28th Rep't, p. 70. 1876. Sacc. Syll. II, p. 729)

The host plant given for this species by Professor Peck is "dead herbaceous stems," but an examination of the type specimens shows that the host is *Thalictrum*. Professor Peck obtained a later collection of this species near North Elba upon a host which he definitely identified as Thalictrum.

Barlaea lacunosa E. & E.

(Proc. Acad. Phil. 1894, p. 347. Sacc. Syll. XL, p. 396)

The only host given for this in the original description is "on bark." The specimen in the herbarium of the New York State Museum, from Waghorne, and presumably a duplicate of the type collection is on bark and dead twigs of Abies balsamea.

Ascochyta clematidina Thüm.

(See figure 1)

During the past two seasons this fungus, parasitic on the leaves of Clematis, has been noted with great frequency, causing a serious disfiguration and frequent death of leaves of the Virgin's-bower (Clematis virginiana) both wild and cultivated. Specimens of diseased leaves were collected in the counties of Albany, Rensselaer, Greene, Oneida, Madison and Onondaga. I assume that the disease, at least as a common parasite of the Clematis, is of recent appearance in this State, although it has been occasionally mentioned in literature as the cause of a serious leaf disease of cultivated Clematis, because there are no specimens in the state herbarium collected by Doctor Peck, who would not have overlooked it if it had been common in past years. It also appears to have been collected by J. M. Macoun, at Ottawa, Canada, in 1897.

Calyptospora columnaris (A. & S.) Kuhn.

Sylvan Beach, Oneida county. On stems of Vaccinium corymbosum Linn. H. D. House, May 13, 1915.

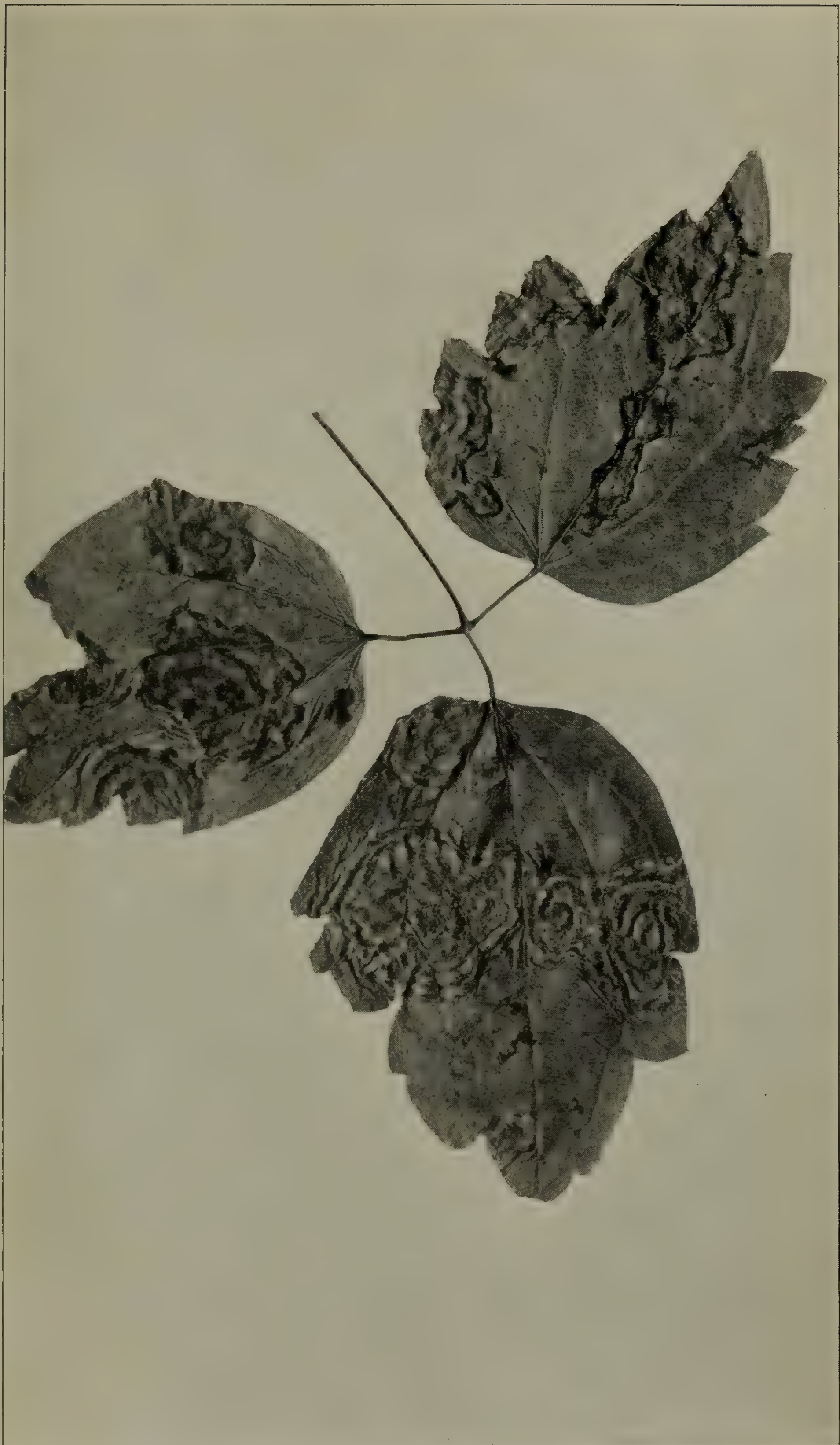


Fig. 1 ascochyta clematidina Thüm

Cercospora chionea E. & K.

Lyndonville. On leaves of Cercis japonica. Dr C. E. Fairman, August 1904. The spores are clavate and shorter than given in the description of C. chionea, but appear to be closer to that species than to C. cercidicola.

Cercospora longispora Peck

Sylvan Beach, Oneida county. On Lupinus perennis Linn. H. D. House, July 3, 1915.

Cercospora rhoina C. & E.

Near Schroeppel's Bridge, Oswego county. On leaves of Rhus copallina L. H. D. House, August 13, 1915.

Dothidella vacciniicola Dearness & House, sp. nov.

Stromata nodular, subglobose, 1–2 mm in diameter at the base, 1–2 mm high, dark brown, reaching to the base of the cortex, becoming hollow, subcarbonaceous.

Ascigerous locules peripherical, mostly but not wholly in a single layer, 6 or 7 to a mm, their position apparent in a surface view; ostiola punctiform 120–150 μ wide, 150 μ deep.

Asci linear to subclavate, tips subconnivent in the locules, 75–90 x 6–7 μ, paraphyses linear, 90–110 μ.

Sporidia hyaline, nearly uniseriate, somewhat overlapping, uniseptate, 10–12 x 5–6 μ.

Parasitic on living twigs of Vaccinium atrococcum (A. Gray) Heller, taken from herbarium plants collected at Biltmore, N. C. H. D. House, May 1912.

Dothidella vaccinii Rostr. inhabits leaves and has larger, appendaged sporidia.

Dendrodochium pallidum Peck

(Bul. Torrey Club 11, p. 50. Sacc. Syll. XI, p. 646)

The host for this species is given by Professor Peck as "rotten wood." An examination of the original specimens collected near Ottawa, Canada, by Professor Macoun shows that the host was decorticated and somewhat decayed maple (Acer).

Dendrophoma cephalanthi Peck

On dead branches of Cephalanthus occidentalis L. at Sylvan Beach, Oneida county. H. D. House, May 10 and June 21, 1915.

Diaporthe obscura Peck

On dead stems of Geum strictum Ait. Pecksport, Madison county. H. D. House, July 2, 1915.

Diatrype woolworthi (Peck) Sacc.

(Valsa woolworthi *Peck*)

The original description states that the host is oak or hickory, and in order to settle definitely the identification of the host a careful examination made of the wood structure of the type specimens shows it to be Hicoria glabra.

Diplodia cercidis E. & E.

On dead twigs of Cercis canadensis L. (cultv.) near Oneida, Madison county. H. D. House, May 15, 1915. Also collected on Cercis japonica at Lyndonville, Orleans county, by Dr C. E. Fairman (no. 929), July 20, 1909.

Ectostroma liriodendri (Kuntze) Fr.

A sterile fungus producing Rhytisma-like spots and blotches on fallen leaves of Liriodendron tulipifera L. Valley Mills, Madison county. H. D. House, July 21, 1913. Also collected at Kirkville, Onondaga county, by Prof. L. M. Underwood, September 1888.

Eutypella glandulosa Cooke

On dead branches of Ailanthus glandulosa Desf. Yonkers. H. D. House, May 8, 1915. Albany, H. D. House, June 10, 1915.

Eutypella ludibunda Sacc.

On dead branches of Viburnum lantana Linn. Cultivated in Washington Park, Albany, N. Y. Collected by H. D. House, March 5, 1915.

The stromata are thickly and evenly scattered along the dead branches of the host, their black disks but slightly raised above the cuticle; perithecia 4–10, immersed in a whitish or wood-colored portion of the cortex and sometimes impressing the wood after the manner of some species of Diaporthe; the pale matrix bears a black covering which becomes continuous as a blackened layer between the cortex and the wood; the perithecia are pale and not of uniform depth in the stroma; stromata short-erumpent, black, some of them very obscurely stellate-cleft; asci sessile, $33–45 \times 6–7\ \mu$; sporidia

biseriate, hyaline, narrowly allantoid, 2–3 nucleate, the nucleus in the middle of many of the spores causing them to appear septate and Diaporthe-like, 10–12 x 2½ μ.

Although there are some slight differences to be noted between the above description and that given by Saccardo, the fungus appears to be closer to E. ludibunda than to any other species described, and the slight differences noted are not sufficient to give it a new name.

Eutypella tumidula (C. & P.) Sacc.

(Valsa Peck, 29th Rep't, p. 58, 1878)

On the original packet of this collection, it is stated by Professor Peck, "on unknown branch." In the original description, however, he states that the host is "Crataegus." An examination of the wood structure of the host material shows that it is Hickory, and apparently Hicoria alba.

Fusicladium depressum B. & Br.

(Didymaria platyspora *Ell. & Holw.;* D. atropurpurea *Ell. & Dearn.;* Scolecotrichium depressum *Bubak*)

Albany, on living and languishing leaves of Angelica atropurpurea L. H. D. House, September 2, 1915. Ithaca, B. B. Higgens (no. 33), August 21, 1911. On leaves of Sium cicutaefolium L. Oneida, Madison county. H. D. House, August 30, 1913. Rouses Point, on same host, C. H. Peck.

Gelatinosporium abietinum Peck

Early in May several specimens of native hemlock growing upon a private estate near West Park, Ulster county, were noticed to be dying from some unknown cause and specimens were sent to the State Botanist's office. Fruiting bodies of Gelatinosporium abietinum were present upon branches that were dead and an examination of the trees upon the estate was made a few days later. The entire top portion of young trees seems to die gradually and sometimes the disease progresses downward, killing the entire tree. In other cases only side branches were killed. In every case the fungus mentioned above was found to be present and while inoculation experiments would be necessary to determine its degree of parasitism, it is strongly suspected of being the cause of the trouble noted in this particular locality. The fungus was originally collected and described from dead branches of hemlock at Greenbush, but later collection of the same fungus was made by Doctor Peck

upon living branches of the hemlock at Elizabethtown, Essex county, and further study of the species may prove it to be the cause of considerable damage to living hemlocks.

Gloeosporium coryli (Desm.) Sacc.

Near Albany, on leaves of Corylus americana Walt. H. D. House *no. 14.136,* September 12, 1914, and August 13, 1915. Hewitt's pond, Adirondacks. Doctor C. H. Peck, July.

Gloeosporium divergens Peck

(See figure 2)

The leaves of the white oak (Quercus alba) are frequently disfigured by the attacks of this fungus and during the season of 1915 several serious outbreaks of this disease were noted in various localities. Young trees, sprout leaves and particularly seedlings in nurseries seem to suffer most severely but mature trees are by no means immune. This is probably the same fungus as described by Ellis and Everhart as Gloeosporium canadense.

Gloeosporium sassafras (Cooke) E. & K.

(Phyllosticta sassafras *Cooke*)

On leaves of Sassafras variifolium (Salisb.) Kuntze. Merrick, Long Island. H. D. House, September 9, 1915.

Haplosporella peckii (Sacc.) House, nom. nov.

(Sphaeropsis anomala *Peck*, 24th Ann. Rep't, N. Y. State Mus. 86, 1872. Not S. anomala *B. & C.*)

Sphaeropsis peckii *Sacc.* Syll. 3:293. 1894.

An odd species with the aspect of a Tympanis, the caespitose perithecia which are seated on the inner bark break through rather large transverse chinks in the bark; ostiola papillate; spores oblong, 20–25 μ in length. On the bark of dead cherry limbs near Albany. (Prescott.)

Hendersonia staphyleae E. & E.

On dead twigs of Staphylea trifoliata L. Green pond near Jamesville, Onondaga county. H. D. House, August 21, 1915. The same species has been collected near Albany by Doctor Peck.

Hygrophorus fuligineus Frost

In rich stony soil in a pine grove near North Bay, Oneida county. H. D. House, October 12, 1915. Doctor Peck reports it only from Albany county, in pine groves. The species is remarkable for the

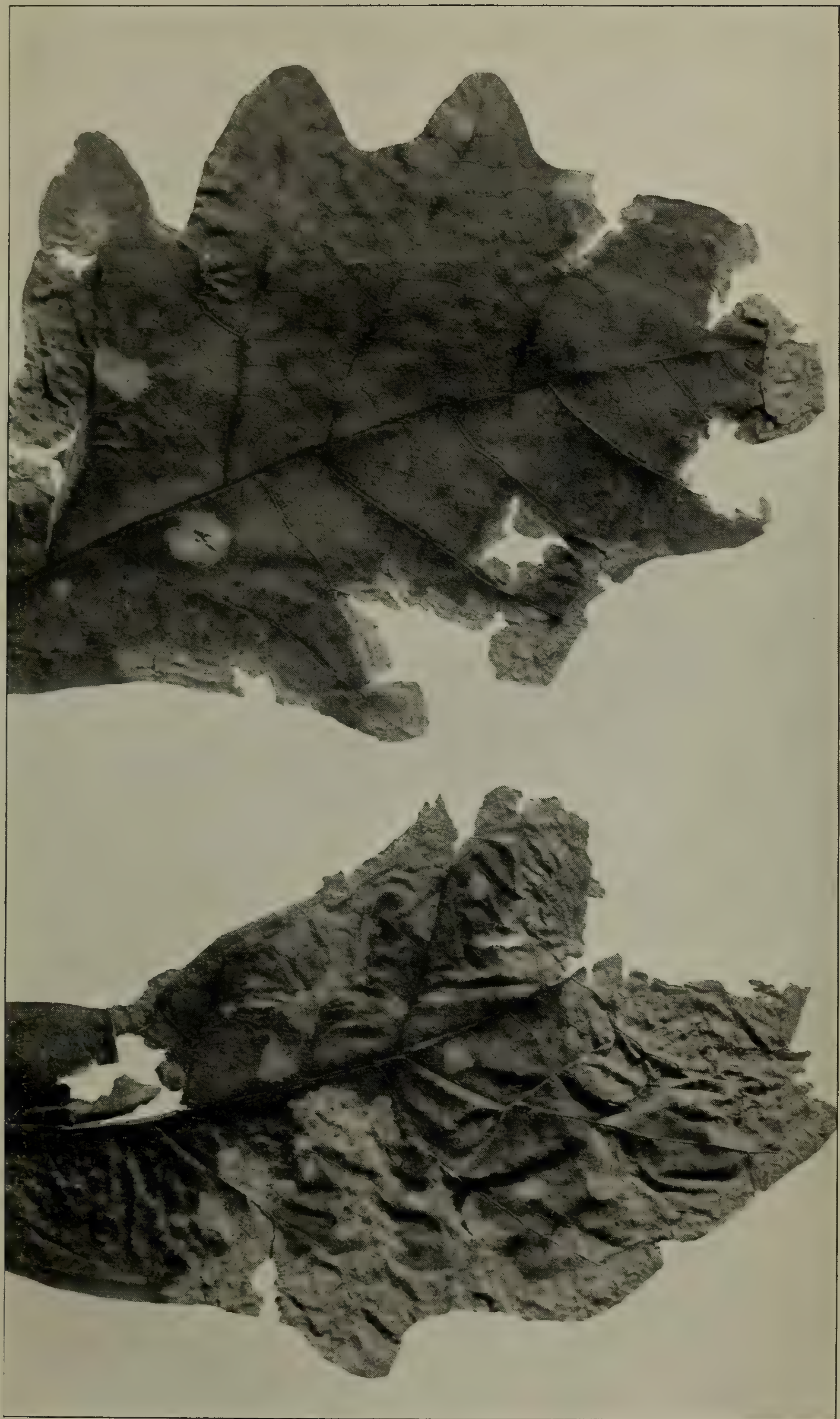


FIG. 2 GLOEOSPORIUM CANADENSE E. & E.

extreme viscidity of the pileus and stem, especially when young, when it is so viscid that it is almost impossible to hold.

Hysterium staphylina (Pk.) Dearness & House

Perithecia thickly scattered, erumpent through the epidermis, shining, black, round, 100–270 μ in diameter to elongate, straight or bent, .25–2 mm x .15–.3 mm, rather widely cleft.

Asci covered by a thin parenchymatous layer, fusoid-clavate, mostly 75 x 15 μ, some shorter and stouter, others much longer and narrower, paraphyses obscure.

Sporidia biseriate to crowded and overlapping, hyaline, 3–7 septate, finally brown and 5–8 septate, second, third or fourth cell from the top enlarged, usually slightly constricted below the lower half; the hyaline spores 18–30 x 5–6 μ, the longest brown spore seen measured 45 x 6 μ.

On dead twigs and branches of Staphylea trifoliata L. Helderberg mountains, N. Y. C. H. Peck, May. This was published as Sphaeria staphylina Peck (= Metasphaeria staphylina Sacc.) in the 26th Report of the State Botanist, page 86, and imperfectly described. This lacks the black crust of Hysterium insidens Schw. but the microscopic characters are similar.

This redescription of Doctor Peck's type material of Sphaeria staphylina was prompted by the discovery in Ulster county of a good Metasphaeria upon the same host and which did not match his material, the name of which had been transferred to Metasphaeria by Saccardo.

Leptostromella hysterioides (Fr.) Sacc.

On dead stems of Helianthus decapetalus L. Kenwood swamp, Oneida, Madison county. H. D. House, May 15, 1915. Sporules curved, 20–21 x 2–2½ μ.

Macrosporium saponariae Peck

Oneida, Madison county, on Saponaria officinalis Linn. H. D. House, June 20, 1915.

Morchella semilibera DC.

Kenwood swamp, near Oneida, Madison county. H. D. House, May 15, 1915. Also collected there in May 1885 by Mr Henry A. Warne, who also collected the same species near Madison, Madison

county. These appear to be the only records of the occurrence of the species in this State.

Nigredo rhyncosporae (Ellis) Arthur

Adirondack mountains on Rhyncospora glomerata (L.) Vahl. C. H. Peck, August. (Taken in abundance from herbarium specimens of this host, collected by Professor Peck several years ago, who apparently overlooked the rust upon it.)

Pestalozzia guepini Desm.

On living and languishing leaves of Smilax glauca Walt. Near Babylon, Long Island. H. D. House, September 19, 1915. The same host plant contained Phyllosticta smilacis E. & M. and what appears to be Physalospora disrupta (B. & C.) Sacc.

Pestalozzia monochaetoidea S. & E.

On dead branches of Opulaster opulifolius (L.) Kuntze. Albany, N. Y. H. D. House, June 5, 1915.

Phacidium sparsum Peck

(Bot. Gaz. 5, p. 35–36. Sacc. Syll. VIII, p. 716.)

Collected in Vermont by C. G. Pringle and the host, given by Peck as dead wood and by Saccardo as "Ligno dejecto," proves to be upon examination white pine (Pinus strobus) wood which is partially decayed.

Phleospora chenopodii E. & K.

(Stagonospora chenopodii *Peck*, Septoria atriplicis *Desm.*, Septoria chenopodii *West*)

On living leaves of Chenopodium album L. Catskill. H. D. House, August 16, 1915.

Phoma bumeliae House, nom. nov.

Phoma maculans *Sacc.* Syll. III:116. 1884. Not P. maculans *Sacc.* l. c. 102. Sphaeropsis maculans *B. & C.* North Am. Fungi No. 417. Not S. maculans *Lev.* (1846).

On leaves of Bumelia, Alabama (Peters).

Phoma verbascicola (Schw.) Sacc.

On dead stems of Verbascum thapsus L. Peckport, Madison county. H. D. House, July 2, 1915. Also collected at Sand lake by Doctor Peck.

Phyllosticta apocyni Trelease

On living leaves of Apocynum androsaemifolium L. Green's pond, near Leeds, Greene county. H. D. House, August 17, 1915. Also collected on the same host at Mechanicville by Doctor Peck.

Phyllosticta liriodendri Cooke

Along the edge of a woodland north of Liverpool, Onondaga county, there was noticed on August 12th, a yellow poplar tree (Liriodendron tulipifera L.) upon which the majority of the leaves were badly disfigured by insect galls and spots upon which appeared a Phyllosticta. About half of the circular brown spots were clearly caused by Phyllosticta liriodendri Cooke (P. circumvallata Wint.). Most of the remaining spots were blisterlike galls with considerable dead tissue surrounding them and caused by the gall midge Thecodiplosis liriodendri Osten Sacken (det. Felt), and upon these spots was a frequent occurrence of Phyllosticta macrospora E. & E., with sporules 18–22 x 6–8 μ. One spot showed the presence of a Sphaeropsis evidently related to Phyllosticta macrospora, while another spot showed a Septogloeum with spores 33–40 x 4 μ. It is interesting to note that Phyllosticta macrospora was also found at Black lake near Catskill on similar spots apparently caused by a gall midge on leaves of Vitis labrusca (August 21, 1915).

Phyllosticta variabilis Pk.

Jamesville, Onondaga county. On leaves of Rubus odoratus. H. D. House, August 9, 1915. Professor Dearness, who compared these specimens with the types of P. variabilis Pk. and P. bicolor Pk., regards all three as essentially the same, although the effect of the fungus upon the leaf tissue seems to be different in each case and the Jamesville specimens have a wider range of spore measurements, namely, 5–8 x 3 μ.

Phyllosticta paviae Desm.

(Phyllosticta sphaeropsoidea *Ell.*)

(See figure 3)

On living leaves of Aesculus hippocastanum L. Catskill, August 18, 1915. This fungus is responsible for a very unsightly disfiguration of the foliage of horse chestnut trees in some localities. Certain trees near Catskill were so badly affected in 1915 that by the end of August practically all the leaves were turning brown and many of them falling. Fortunately the disease does not appear to reoccur with equal abundance from year to year. Mr V. B. Stewart (Abs. in Phytopathology 4:399. 1914) shows that the sexual stage of Phyllosticta paviae is Laestadia aesculi Peck which occurs commonly upon the fallen petioles and leaves.

Physalospora ceanothina (Peck) Sacc.

(Sphaeria ceanothina *Peck*)

On dead twigs of Ceanothus americanus Linn. Karner, Albany county. H. D. House, April 1915. The type was also collected at Karner by Professor Peck in May 1875.

Poria attenuata Peck

Karner, Albany county. H. D. House, *no. 148,* October 3, 1914. Sylvan Beach, Oneida county. H. D. House, October 12, 1915. Rather common on dead hardwood sticks on the ground in moist woods and thickets.

Phyllosticta phomiformis Sacc.

(See figure 4)

This fungus, common on the leaves of Quercus alba, prinus and prinoides, appears to be invariably associated with the insect galls caused by Cincticornia, and is therefore of a saprophytic nature, although occurring on living leaves. This species has been transferred to the genus Macrophoma, but all our specimens have spores much smaller than described by Saccardo and it is quite possible that they should not be referred to his species.

Phoma galactis Dearness & House, n. sp.

Pycnidia subcuticular, hemispheric, black, thickly scattered, 200 μ in diameter; spores pyriform, hyaline, on basidia of about the length of the spores which are very small, oblong, $2\frac{1}{2}$–$3 \times 1\frac{1}{2}$ μ.

Dead flowering stems of Galax aphylla L. Biltmore, N. C. H. D. House, May 1912.

FIG. 3 PHYLLOSTICTA PAVIAE DESM.

Fig. 4 PHYLLOSTICTA PHOMIFORMIS Sacc.

Poria calcea Fr.

North Greenbush, Rensselaer county. H. D. House, *no. 233,* October 10, 1914.

Ramularia arvensis Sacc.

On living leaves of Potentilla monspeliensis L. Oneida, Madison county. H. D. House, June 27, 1915. Also collected at Newman, N. Y., on the same host by Doctor Peck.

Ramularia barbareae Peck

Sylvan Beach, Oneida county. On leaves of Barbarea vulgaris R. Br. H. D. House, May 10, 1915.

Ramularia obovata Fckl.

On living and languishing leaves of Rumex crispus L. Albany. H. D. House, July 23, 1915. Karner. October 8, 1914. This is the form with obovate, nonseptate conidia. The one with clavate-oblong 1-septate spores is known as Ramularia obliqua (Cooke) Oud., and appears to be the one most frequently collected in this State. By some these two are regarded as forms or phases of the same species, to which may also be united Ramularia decipiens E. & E.

Rhizina inflata (Schaeff.) Quel.

(R. undulata *Fr.*)

Under hemlock and birch trees, Pleasant Lake north of Schroeppels Bridge, Oswego county. H. D. House, August 11, 1915. Doctor Peck has collected this species at Forestburg, Sullivan county, Hague, Warren county and Greig, Lewis county. At the Oswego county locality the fungus appears to be chiefly saprophytic, but several instances were observed where the mycelium of the fungus invested and was apparently parasitic on hemlock seedlings, causing their death.

Septogloeum ochroleucum (B. & C.) Dearness, com. nov.

(Septoria ochroleuca *B. & C.;* Phyllosticta, *Pk.;* Gloeosporium, *B. & C.;* Cryptosporium epiphyllum *C. & E.*)

Schroeppels Bridge, Oswego county, on living leaves of Castanea dentata (Marsh.) Borkh. H. D. House, August 13, 1915. Also collected by Doctor Peck at Sand Lake, Copake and Wading River.

Septoria atropurpurea Peck

On living leaves of Aster corymbosus Ait. Karner, Albany county. H. D. House, July 26, 1915. The following host species for this fungus are represented in the state herbarium in addition to the above: Aster macrophyllus (N. Y. Peck, *type*); Aster drummondii (Wisc. Davis); Aster laevis (Ontario, Dearness); Aster corymbosus (Ontario, Dearness).

Septoria conspicua E. & M.

On living leaves of Lysimachia quadrifolia L. near Huntington, Long Island. H. D. House, September 17, 1915.

Septoria erigerontis Peck

On leaves of Erigeron annuus L. Albany. H. D. House, July 25, 1915. On leaves of E. pulchellus, Cicero, Onondaga county, August 12, 1915. On leaves of E. philadelphicus, Oneida, Madison county. May 14, 1915.

Septoria verbenae Rob. & Desm.

On living leaves of Verbena hastata L. Outlet of Onondaga lake, Onondaga county. H. D. House, August 10, 1915. On same host, Pecksport, Madison county. July 2, 1915. Albany, June 19, 1915.

Septoria wilsoni Clinton

On living leaves of Chelone glabra L. North of Liverpool, Onondaga county. H. D. House, August 10, 1915. On same host, Albany, July 25, 1915. Other collections of this species, on the same host, in the state herbarium are Buffalo (Clinton, *type*); Alcove (Shear); North Elba and Caroga (Peck).

Sphaeropsis ailanthi Ell. & Barth.

Albany, N. Y., on dead twigs of Ailanthus glandulosa Desf. H. D. House, February 22, 1915.

Sphaeropsis conspicua House, nom. nov.

Sphaeropsis maculans *Peck*, 39th Rep't, N. Y. State Museum, p. 46. 1886. Not S. maculans *Lev.*, Ann. Sci. Nat. 1846, p. 297.

Perithecia immersed, 400–500 μ broad, black; ostiola papillate; sporules elliptical, colored, 10–12.5 x 5–6.5 μ.

On decorticated dead twigs (apparently Acer), Adirondack mountains. May 1885 (Peck).

Sphaeropsis linearis Peck

(25th Ann. Rep't, N. Y. State Museum, p. 86. 1873)

Professor Peck states that S. linearis occurs on oak but an examination of the type material shows that an error was made in the identification of the host which proves to be unmistakably hickory, and hence the name S. linearis Peck must replace the name Sphaeropsis caryae C. & E., having priority over it, and being identical in all particulars. Curiously enough, while the type host material is unmistakably hickory, I have an abundant collection on twigs of Quercus alba, Albany, March 14, 1915, of which Professor Dearness, after a careful examination, says, "So near S. linearis, if it is not exactly that, as to leave no room to make another species of it." The species must therefore be credited to both hickory and oak.

Sphaeropsis sepulta E. & E.

(S. mori *E. & E.*)

Albany, N. Y. On dead twigs of Morus alba L. H. D. House, February 22, 1915. Also collected at Orient Point, Long Island, by Roy Latham and at Southfield, Long Island, by Professor Peck on Morus alba, and at West Albany, on Morus rubra, by Professor Peck.

Vermicularia compacta C. & E.

On dead stems of Saponaria officinalis L. Sylvan Beach, Oneida county. H. D. House, May 10, 1915. Trichia few, 40–60 x 4–6 μ; sporules arcuate, acute, 20–22 x 2.5–3 μ.

Vermicularia herbarum (Pers.) Fr.

Among the numerous hosts upon which this has been found during the past season, may be mentioned the following: Aralia nudicaulis (spores 20–25 x 3 μ); Vitis labrusca; Aster macrophyllus; Sambucus canadensis; Fraxinus americana; and Meibonia canadensis.

Vermicularia liliacearum Westd.

On dead stems of Uvularia perfoliata L. Oneida, Madison county. H. D. House, May 14, 1915. "Trichia numerous; sporules 20 x 2¾–3 μ."

Valsa ambiens (Pers.) Fr.

Very abundant on dead twigs of Ceanothus americanus L. Albany. H. D. House, November to March. Also collected at New Scotland, Albany county, on the same host by Professor Peck and on Ceanothus ovatus Desf. near New York by H. D. House.

Valsa subclypeata C. & P.

Sylvan Beach, Oneida county. On dead limbs of Sassafras variifolium (Salisb.) Kuntze. H. D. House, May 10, 1915.

Venturia cassandrae Peck

Pecksport, Madison county. On fallen leaves of Chamaedaphne calyculata (L.) Moench. H. D. House, July 2, 1915. Also collected at Karner, Albany county, April 22, 1915.

The following species of Asterostroma, Corticium, Coniophora, Hypochnus, Merulius, Odontia, Peniophora and Poria have been determined in major part by Prof. E. A. Burt of the Missouri Botanical Garden, St Louis, to whom the specimens were submitted for identification or verification.

Asterostroma cervicolor (B. & C.) Massee

Near Albany, on decaying decorticated branches lying on the ground in the woods. H. D. House and Joseph Rubinger, October 23, 1915.

Corticium colliculosum B. & C.

Near Albany, on dead limbs of Prunus pennsylvanica L. H. D. House, November 26, 1915.

Corticium evolvens Fr.

Sylvan Beach, Oneida county, on dead oak branches lying on the ground. H. D. House, October 12, 1915. Albany, November 26, 1915, on the same host and also on bark of decayed maple limbs.

Corticium berkeleyi Cooke

Near Albany, on bark of Pinus strobus. H. D. House and Joseph Rubinger, October 23, 1915. Newtonville, on the same host. Dr C. H. Peck (date of collection not indicated).

Corticium alutaceum (Schrad.) Bres.

Near Albany, on decayed bark and wood. H. D. House and Joseph Rubinger, October 23, 1915.

Corticium investiens (Schw.) Bres.

(Thelephora subochracea *Peck*)

Karner, Albany county. H. D. House, October 3, 1914. Albany, H. D. House and Joseph Rubinger, October 23, 1915. One of the commonest species of the genus and apparently showing little choice of host, growing on and investing leaves, sticks, twigs, bark and branches of both coniferous and deciduous species lying on the ground in the woods. It has also been collected by Doctor Peck at Shokan, Floodwood, Schuylerville and Snyder's Corners.

Corticium laetum Karst.

Karner, Albany county. H. D. House, *nos. 161 and 164,* October 3, 1914.

Corticium mutatum Peck

Near Albany, on bark of fallen and decaying limbs of Populus tremuloides. H. D. House, November 26, 1915.

Corticium roseopallens Burt

Karner, Albany county. H. D. House, *no. 170,* October 3, 1914. Near Sylvan Beach, Oneida county, on bark of decayed birch limbs.

Corticium atrovirens Berk.

Karner, Albany county. H. D. House, *no. 205,* October 8, 1914.

Corticium effuscatum C. & E.

Karner, Albany county. H. D. House, *no. 210,* October 8, 1914. Greenbush, Rensselaer county. H. D. House, *no. 236,* October 10, 1914. Not a rare species, at least in this part of the State, having also been collected by Doctor Peck at East Berne, Westport and East Schaghticoke.

Corticium epigaeum E. & E.

Karner, Albany county. On dead twigs lyings on the ground in woods. H. D. House, *no. 160,* October 3, 1914.

Coniophora olivascens (B. & C.) Massee

Albany. On fallen branches in woods. H. D. House, November 26, 1915. At the same place and date were collected the much commoner species Coniophora puteana Schum. on fallen pine limbs and Coniophora arida Fr. on decaying coniferous log.

Corticium suffocatum Peck

Karner, Albany county. H. D. House, *no. 165*, October 3, 1914. Originally collected at Sand lake by Doctor Peck and generally referred to the genus Coniophora.

Corticium sambuci Fr.

Near Albany. On dead limbs of hickory lying on ground in woods. H. D. House and Joseph Rubinger, October 12, 1915. Clarksville. On decayed wood and bark of Juglans cinerea. Dr C. H. Peck (date of collection not indicated).

Corticium vagum B. & C.

Near Albany, on decayed and decorticated hemlock limbs lying on ground in woods. H. D. House and Joseph Rubinger, October 23, 1915.

Hypochnus granulosus (Peck) Burt

(Zygodesmus granulosus *Peck;* H. elaeodes *Bres.*)

Karner, Albany county. H. D. House, *no. 211*, October 8, 1914. Near Albany. H. D. House and Joseph Rubinger, October 23, 1915. Zygodesmus granulosus was collected by Doctor Peck at East Schaghticoke, and the state herbarium also contains an additional specimen collected at Flatbush by Zabriskie.

Hypochnus subferrugineus Burt

Sylvan Beach, Oneida county. On decayed bark and wood of oak. H. D. House, October 12, 1915.

Hypochnus olivaceous (B. & C.) Burt

Karner, Albany county. H. D. House, *no. 167*, October 3, 1914. North Greenbush, Rensselaer county. On dead hemlock bark. H. D. House, November 25, 1915.

Hypochnus fuscus (Pers.) Fries

Near Albany. On dead branches of pine. H. D. House and Joseph Rubinger, October 23, 1915.

Merulius bellus B. & C.

Near Albany. On decayed hemlock limbs lying on ground in woods. H. D. House and Joseph Rubinger, October 23, 1915.

Odontia trachytricha (E. & E.) Burt

(Peniophora trachytricha *E. & E.*, Odontia acerina *Pk.*)

Karner, Albany county. H. D. House, *no. 207*, October 8, 1914.

Peniophora affinis Burt

Albany. On bark of fallen and decayed branches. H. D. House, November 26, 1915.

Peniophora crassa Burt

Sylvan Beach, Oneida county. On charred undersurface of logs of Pinus rigida. H. D. House, October 12, 1915.

Peniophora filamentosa (B. & C.) Burt

(Peniophora unicolor *Peck*)

North Greenbush, Rensselaer county. H. D. House, *no. 235*, October 10, 1914. Same locality, on bark of decayed branches of Ulmus americana lying on ground in woods, November 25, 1915. The type of P. unicolor Peck was collected at Bolton, Warren county.

Peniophora incarnata Fr.

Albany, on fallen and decorticated branches of Prunus pennsylvanica. H. D. House, November 26, 1915.

Peniophora laevis (Fr.) Burt

Karner, Albany county. H. D. House, *no. 153*, October 3, 1914. North Greenbush, Rensselaer county. H. D. House, *no. 234*, October 10, 1914.

Peniophora longispora Pat.

East Berne, Albany county. On decayed log. Dr C. H. Peck (date of collection not indicated).

Peniophora pubera (Fr.)

Karner, Albany county. H. D. House, *no. 206*, October 8, 1914.

Peniophora sordida Karst.

Karner, Albany county. H. D. House, *no. 188*, October 3, 1914.

Peniophora velutina DC.

Sylvan Beach, Oneida county. On charred undersurface of maple log. H. D. House, October 12, 1915.

Poria pulchella Schw.

Sylvan Beach, Oneida county. On charred undersurface of logs in woods. H. D. House, October 12, 1915.

Rhinotrichum curtisii Berk.

North Greenbush, Rensselaer county. On bark of decayed oak limbs on ground in open woods. H. D. House, November 25, 1915.

Stereum rameale Schw.

Albany, on dead limbs of Prunus pennsylvanica. H. D. House, November 26, 1915.

NOTES UPON LOCAL FLORAS III

MADISON COUNTY

Antennaria neglecta Greene

Oneida. H. D. House, June 4, 1914. Pecksport. H. D. House, June 5, 1915.

Antennaria grandis (Fernald) House

Pecksport. H. D. House. June 10, 1914.

Antennaria fallax Greene

Oneida. H. D. House, June 4, 1914.

Antennaria parlinii Fern. var. **arnoglossa** Fern.

Thin soil on limestone ledges in open woods, Chittenango Falls. H. D. House, June 9, 1914.

MONROE COUNTY

Antennaria occidentalis Greene

(A. Farwellii *Fern.* not *Greene*)

East Rochester. M. S. Baxter, *nos. 319 and 320,* October 1912 and May 23, 1913.

Antennaria petaloidea Fernald

Penfield. M. S. Baxter, May 23, 1915.

Antennaria fallax Greene

Perinton and East Rochester. M. S. Baxter, May 23–25, 1915.

Antennaria ambigens (Greene) Fernald

Greece and Perinton. M. S. Baxter, May 17 and 25, 1913.

Antennaria neodioica Greene

Perinton. M. S. Baxter. May 17, 23 and 25, 1915.

Antennaria canadensis Greene

Penfield and Perinton. M. S. Baxter, May 23 and 25, 1915. Near Greece. M. S. Baxter, May 17, 1913.

Antennaria plantaginifolia (L.) Richard.

Greece and Perinton. M. S. Baxter, May 17, 23 and 25, 1913.

Antennaria grandis (Fernald) House

Perinton. M. S. Baxter, May 25, 1915.

Antennaria neglecta Greene

East Rochester, Perinton, Greece and Penfield. M. S. Baxter, May 1913.

Chamaesyce glyptosperma (Engelm.) Small

(Euphorbia glyptosperma *Engelm.*)

Sandy soil, Irondequoit. M. S. Baxter, August 1915. A rare species in the east. Reported from Fisher's Island, N. Y., and from Oxford county, Maine, while its usual range is given as Ontario to Wisconsin, Missouri and westward.

Selaginella ruprestris (L.) Spring.

Sandy plains near Penfield. M. S. Baxter, October 31, 1915. A local but not particularly rare species. This record is interesting as indicating that while its usual habitat is dry rocky ledges, it may sometimes occur in dry sandy places.

NASSAU COUNTY

September 8th and 13th were spent in and around the salt marshes just north of Long Beach, and on Long Beach itself. The species observed at this season constitute an interesting list for this locality, and are characteristic for the extensive salt marshes on this part of Long Island.

Agalinis maritima *Raf.*
" purpurea (*L.*) *Britton*
Angelica atropurpurea *Linn.*
Argentina anserina (*L.*) *Rydb.*
Aster novi-belgii *Linn.*
" salicifolius *Lam.*
" subulatus *Michx.*
" tenuifolius *Linn.*
Atriplex hastata *Linn.*
Baccharis halimifolia *Linn.*
Cakile edentula (*Bigel.*) *Hook.*
Chamaecrista fasciculata (*Michx.*) *Greene*
Clethra alnifolia *Linn.*
Cyperus strigosus *Linn.*
Cuscuta gronovii *Willd.*
Distichlis spicata (*L.*) *Greene*
Dondia linearis (*Ell.*) *Heller*
Echinochloa walteri (*Pursh*) *Nash*
Elymus virginicus *Linn.*
Falcata comosa (*L.*) *Kuntze*
Fimbristylis autumnalis (*L.*) *R. & S.*
Fuirena squarrosa *Michx.*
Glycine apios *Linn.*
Helianthus angustifolius *Linn.*
" giganteus *Linn.*
Hibiscus moscheutos *Linn.*
" oculiroseus *Britt.*
Hydrocotyle verticillata *Thumb.*
Ibidium cernuum (*L.*) *House*
Iva frutescens *Linn.*
Juncus gerardii *Lois.*
Limonium carolinianum (*Walt.*) *Britt.*
Lysimachis terrestris (*L.*) *B. S. P.*
Mikania scandens (*L.*) *Willd.*

Marsicus mariscoides (*Muhl.*) *Kuntze*
Persicaria pennsylvanica (*L.*) *Small*
Plantago maritima *Linn.*
Puccinellia distans (*L.*) *Parl.*
Ptilimnium capillaceum (*Mx.*) *Raf.*
Polygonum prolificum (*Small*) *Rob.*
Panicum dichotomiflorum *Michx.*
Pluchea camphorata (*L.*) *DC.*
Samolus floribundus *H. B. K.*
Salsola kali *Linn.*
Salicornia europaea *Linn.*
Sabbatia dodecandra (*L.*) *B. S. P.*
" stellaris *Pursh*
Scirpus americanus *Pers.*
" robustus *Pursh*
Solidago sempervirens *Linn.*
Spergula arvensis *Linn.*
Spartina cynosuroides (*L.*) *Roth*
" patens (*Ait.*) *Muhl.*
Teucrium littorale *Bicknell*
Tissa marina (*L.*) *Britt.*
Triglochin maritima *Linn.*
Stroptostyles helvola (*L.*) *Britt.*
Vernonia noveboracensis (*L.*) *Willd.*
Viola lanceolata *Linn.*
" brittoniana *Pollard*
" pectinata *Bicknell*
Xanthium echinatum *Murr.*

Althaea officinalis Linn.

In and around the margins of brackish and salt water marshes near Port Washington. H. D. House, September 16, 1915. A native of Europe which has become very abundant on this part of Long Island.

Sanguisorba canadensis Linn.

Very abundant in a swamp along the Merrick road between Merrick and Freeport. H. D. House, September 9, 1915.

Lespedeza stuvei Nutt.

Dry banks along a roadside through deciduous woodland near Port Washington. H. D. House, September 16, 1915.

Lonicera sempervirens Linn.

Open woods near Sand's Point, Long Island. H. D. House, September 16, 1915. This is a common species in the south, but is very rare in New York, although it has been reported from southern New England. In Paine's Catalogue of the Plants of Oneida County and Vicinity, it is recorded as having been found by J. H. Hall at Tarrytown and on the hills eastward, and on the borders of Otsego lake, Otsego county, by B. D. Gilbert and H. Lathrop. The latter is an outlying station for the species comparable to some of the isolated northern stations in New York State for Ilex montana, Ophrys australis, Blephariglottis ciliaris, Rhyncospora corniculata, Lathyrus ochroleucus and other species. The report of the Director of the State Museum for 1915 contains a colored plate illustrating this species, the photograph of which was taken at this locality.

Tagetes erecta Linn.

In a waste place near a roadside not far from Rockville Center, where rubbish had evidently been dumped at one time. The Marigold, as this species is known, is a common plant of old gardens in America but appears to have become established but rarely in this latitude although perfectly hardy in cultivation. Our specimens were single, possessing disc and ray flowers instead of the large mass of crinkled rays common in the cultivated varieties, and bore an abundance of good seeds. Numerous specimens in the immediate vicinity seemed to indicate that the species was well established and propagating itself by seed from year to year.

ONEIDA COUNTY

Polygonum buxiforme Small

Forming broad mats on the sandy shores of Oneida lake near Sylvan Beach. H. D. House, October 11, 1915.

Polygala pauciflora Willd.

Edge of pine woods, North Bay. H. D. House, June 25, 1915.

Panicum ashei Pearson

Open woods, sandy soil, North Bay. H. D. House, June 19, 1915. Also collected at Ithaca in 1884 by Prof. William Dudley.

Panicum columbianum Scribn.

Sandy soil along margin of oak woods. H. D. House, July 24, 1914.

Panicum addisonii Nash

Sandy soil, near Sylvan Beach. Dr J. V. Haberer.

Panicum implicatum Scribn.

Sandy fields near Sylvan Beach. H. D. House, July 24, 1914. Near Deerfield (Haberer). Also collected by Professor Peck at Fulton Chain, North Elba, Gansevoort and North Albany.

Panicum sphaerocarpon Ell.

Sandy fields near Sylvan Beach. H. D. House, July 20, 1914.

Panicum lindheimeri Nash

Open sandy woods near Sylvan Beach. H. D. House, July 20, 1914. Also collected in Bergen swamp, Genesee county, and at Amagansett, Long Island, by Professor Peck.

Panicum spretum Schult.

Sandy soil near Sylvan Beach. H. D. House, June 21, 1915. A species apparently widely distributed throughout the State, having been collected by Professor Peck at Whitehall, West Albany and Riverhead, at Orient Point by Roy Latham and at Penfield, Monroe county, by M. S. Baxter. The collections by H. D. House mentioned above have all been determined by Prof. A. S. Hitchcock.

Panicum xanthophysum A. Gray

Moist places in sandy woods near Sylvan Beach. H. D. House, July 20, 1915.

Panicum werneri Scribn.

Dry thickets, North Bay. H. D. House, June 1915.

Antennaria neglecta Greene

Sylvan Beach, eastern end of Oneida lake. H. D. House, June 4, 1914.

Antennaria grandis (Fern.) House

Sylvan Beach. H. D. House, June 5, 1915.

Antennaria fallax Greene

Sandy fields near Sylvan Beach. H. D. House, June 8, 1914. Also collected here by Doctor Haberer, June 1, 1903.

Panicum boreale Nash

Open woods near North Bay. H. D. House, July 1915.

Panicum tennessensis Ashe.

Dry oak woods near Sylvan Beach. H. D. House, June 1915.

Trillium cernuum Linn.

Low sandy woods and thickets near Sylvan Beach. H. D. House, May 1915.

ST LAWRENCE COUNTY

Viola selkirkii Pursh

Near Canton. Mrs Orra Parker Phelps, May 2, 1915. The great-spurred violet, although locally abundant, is rather sparingly distributed throughout the Northeastern states and Canada. In

New York it has been collected near Utica, Oneida county; Minerva, Essex county; W. Albany, Albany county; Little Falls, Herkimer county; Oneida, Madison county; and Jamesville, Onondaga county.

Antennaria canadensis Greene

Collected at Colton, Lisbon, Canton and Hopkinton by Mrs Orra Parker Phelps, May 13–25, 1915.

Antennaria neodioica Greene

Collected at Hopkinton, Stockholm, Hammon, Norfolk and Canton by Mrs Orra Parker Phelps, May 13–25, 1915.

Antennaria fallax Greene

Near Hammond. Mrs Orra Parker Phelps, May 19, 1915.

Antennaria petaloidea Fernald

Near Canton. Mrs Orra Parker Phelps, May 25, 1915.

Antennaria neglecta Greene

Near Stockholm. Mrs Orra Parker Phelps, May 19, 1915.

SUFFOLK COUNTY

Panicum commonsianum Ashe

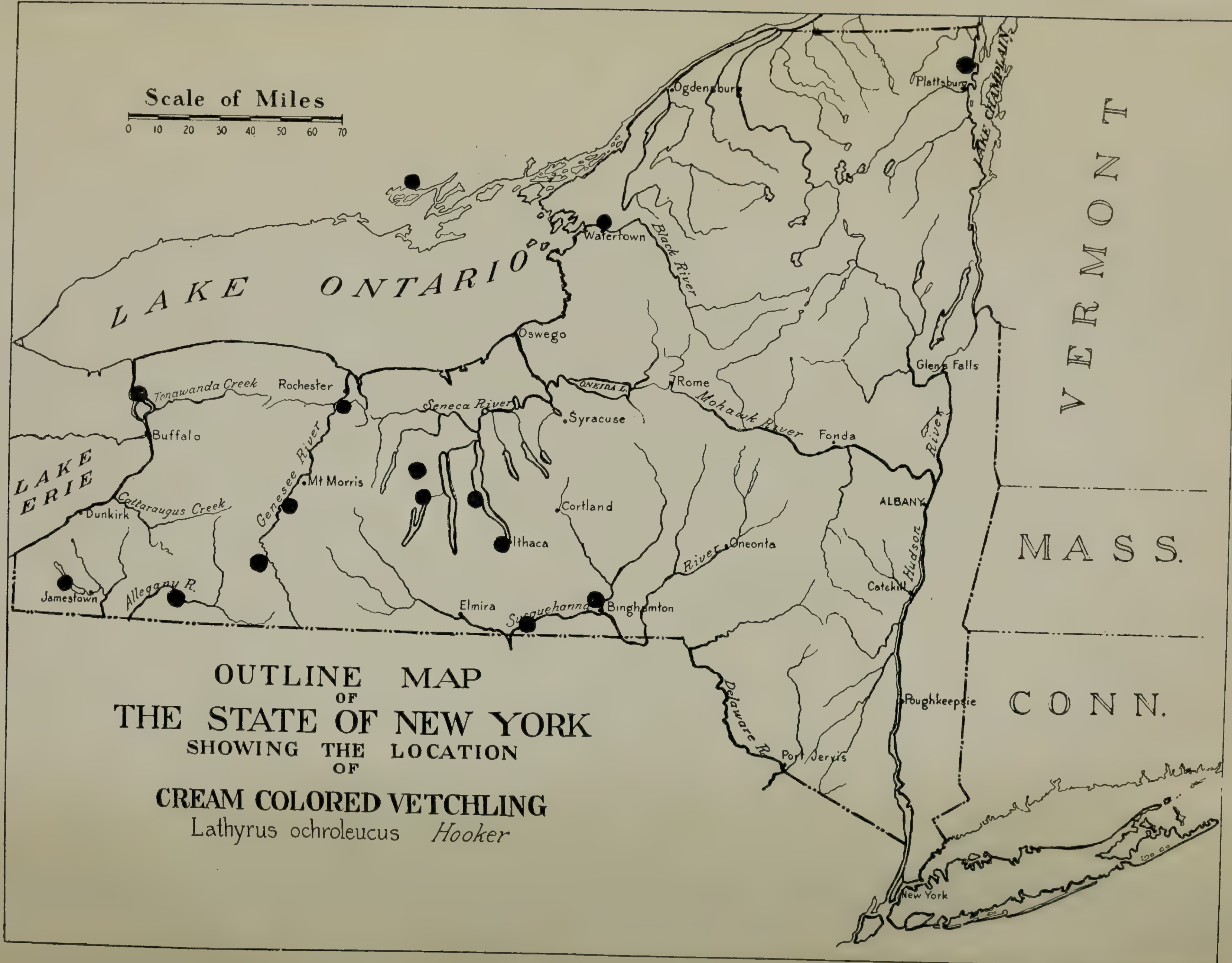
Riverhead. Charles H. Peck. July. Determined by Prof. A. S. Hitchcock.

Hypericum densiflorum Pursh

Near Babylon. H. D. House, September 21, 1915. A species common in the sandy coastal plains and barrens of New Jersey as far north in the State as they extend, but apparently not previously recorded from Long Island.

Aster spectabilis Ait.

Edge of woods in sandy soil, near Babylon. H. D. House, September 21, 1915. Almost without question the most showy of the blue-flowered Asters of the north.



OUTLINE MAP
OF
THE STATE OF NEW YORK
SHOWING THE LOCATION
OF
CREAM COLORED VETCHLING
Lathyrus ochroleucus *Hooker*

WARREN COUNTY

Elymus glaucus Buckley

Warrensburg. Charles H. Peck, July. Determined by Prof. A. S. Hitchcock, to whom was submitted a large number of undetermined grasses collected by Professor Peck. The range given for this species is "Ontario and Michigan to British Columbia, Colorado and California." The Warren county collection constitutes not merely a new species for the state flora but a remarkable eastward extension to the known range of the species.

Pyrola asarifolia Michx.

Bog near Horicon. Dr Charles H. Peck, July. The exact year is not given, but the specimens were detected amongst some undetermined material collected between 1907 and 1910.

WYOMING COUNTY

Cathartolinum sulcatum (Riddell) Small

Near Portageville. Dr Charles H. Peck, July 1908. Detected among the undetermined specimens of Professor Peck's collecting, and rather easily distinguished by the united styles.

Lathyrus ochroleucus Hook.

Near Portageville. Dr Charles H. Peck, May 1905. This must be regarded as one of the rare species of the state flora. It was collected nearly three-fourths of a century ago at Watertown, Jefferson county, by Crawe, and in Paine's Catalogue of the Plants of Oneida County and Vicinity two additional localities are mentioned, namely, Gorham, Ontario county (Sartwell), and Monroe county (C. M. Booth). In addition to these stations it has been collected at Penn Yan, Sartwell (in Nat. Herb.); western New York, Sartwell (in Gray Herb.); Lake Chautauqua, J. R. Churchill (in Gray Herb.); Ithaca, Tompkins county by Charles S. Sheldon in 1878 (N. Y. State Herb.); at Belfast, Allegany county, and Carrollton, Cattaraugus county, by Charles H. Peck. With the exception of the Watertown locality, its range appears to be confined in this State to the western and southwestern counties.

The species was collected at Belleville, Ontario, June 1877, by Professor Macoun, a station even farther north than Watertown. Its distribution in New York State is shown by the accompanying map.

A BIBLIOGRAPHY OF THE BOTANY OF NEW YORK STATE

One of the signs of progress in botany is the increasing attention given to the study of local vegetation and its ecological relations. A local flora has been published for nearly every section of the State in addition to a large number of county and sectional floras, which for the most part are exceptionally complete. The number of published papers dealing with various phases of local botany in this State is very large and one of the disadvantages to be encountered in the study of local flora problems is the difficulty of locating quickly the references to the published literature dealing with a given locality or section.

The bibliography here presented aims to group the titles bearing upon the subject in such a manner as to show the nature, quantity and authorship of the various studies upon the flora of the State and its natural and political subdivisions.

Citations dealing with economic botany (agriculture), plant pathology and forestry have been for the most part omitted, although it is obviously difficult to draw a line of distinction, especially where record is made in such articles to native species of fungi or flowering plants constituting an original observation or addition to the flora of some section of the State. Upon this ground alone have several titles dealing with plant pathology, agriculture and forestry been admitted.

Since the aim of this bibliography is to present the citations by localities rather than by authors, the arrangement takes the following order:

1 New York State in General
2 State Botanist's Reports
3 Adirondack Mountains
4 Catskill Mountains
5 Central New York
6 Hudson River Valley
7 Long Island
8 Susquehanna Valley
9 Western New York
10 Citation of Titles by Counties
Index to Citations by Authors

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New Stations of Rare Plants and Notable varieties, p. 133–35.

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Synopsis of the New York Pucciniae, p. 110–23.

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3 ADIRONDACK MOUNTAINS

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9 WESTERN NEW YORK

(See also under counties of the western part of the State)

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10 CITATION OF TITLES BY COUNTIES

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See also Flora of the Vicinity of New York by Norman Taylor, and citations under Hudson River valley.

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A Catalogue of Indigenous Plants Found Growing in the Vicinity of Kinderhook Academy. W. V. S. Woodworth. 52d Annual Report of the Regents, 253–54. Albany 1839. 53d Annual Report of the Regents, 208–10. Albany 1840 (title not indicated for latter list)

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See also citations under Western New York.

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The Fungi of North Elba. C. H. Kauffman. New York State Museum Bul. 179, p. 80–104. 1915

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(See also Paine's Flora of Oneida County)

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A Preliminary List of the Plants Found in the Ridgewood Water Supply of the City of Brooklyn, Kings County, N. Y. Smith Ely Jelliffe. Torrey Club Bul., 20:243–46. June 17, 1893

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A Few Plants of the North Woods. Benjamin D. Gilbert. Torrey Club Bul., 6:362–63. 1879

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List of Trees and Woody Plants Growing Spontaneously in Madison and Onondaga Counties. L. M. Underwood. Geological Formations Madison and Onondaga Counties, 8vo., pamphlet, p. 16, 17. Syracuse 1879

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NEW YORK COUNTY

(For vicinity of New York, see Long Island, Richmond county, Kings county, Nassau county, Bronx county, Westchester county and Queens county)

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3 Torreya, 10: 80–83. 1910
4 Torreya, 10: 145–49. 1910
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6 Torreya, 10: 224–28. 1910
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9 Torreya, 11: 170–74. 1911
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Key to the Wild Herbs Flowering in the Spring. Chester A. Darling. Torreya, 12:46–65. 1912

A Preliminary List of the Lichens Found within a Radius of One Hundred Miles of New York City. George C. Wood. Torreya, 14:73–95. 1914

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(See also western New York)

A Catalogue of the Flowering and Fernlike Plants Growing without Cultivation in the Vicinity of the Falls of Niagara. David F. Day. Annual Report of the Commission for the State Reservation at Niagara, 67–133. 1888. Also reprinted as pamphlet, 67 pages. Troy 1888

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(See also central New York)

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Catalogue of Plants Found in the County of Oneida. Peter D. Kneiskern. 55th Annual Report of the Regents, p. 273–99. Albany 1842

Catalogue of Plants Found in Oneida County and Vicinity. John A. Paine, jr. 18th Annual Report of the Regents on the Cabinet, p. 53–192. Albany 1865. Also reprinted, 140 pages.

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ONONDAGA COUNTY

(See also central New York)

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The Ferns of Onondaga. Mrs S. M. Rust (Mary Oliva Rust) The Sunday Courier, March 7, 1880. Syracuse. Reprint: "Filices Onondagensis." 1 page

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The Ferns of Scolopendrium Lake (Green Pond, Jamesville). L. M. Underwood. Fern Bulletin, 5:53–54. 1897

The Story of a Fern Hunt. George Duryea Hulst. Fern Bulletin, 9:1–2. 1901

Outings for Onondaga Moonwort and Slender Cliffbrake. H. E. Ransier. American Fern Journal, 2:119–21. 1912

Flora of Onondaga. Mrs L. L. H. Goodrich. 210 pages. Syracuse 1912

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ONTARIO COUNTY

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ORLEANS COUNTY

(See also western New York)

Hymenomycetes of Orleans County, N. Y. Charles Edward Fairman. Rochester Academy of Science Proc., 2:154–67. 1893

Puff Balls, Slime Moulds and Cup Fungi of Orleans County, N. Y. Charles Edward Fairman. Rochester Academy of Science Proc., 3:206–20. 1900

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Wild Flowers of New York

Explanations of plates

Plate 1

PEARLY EVERLASTING

(Compositae)

Anaphalis margaritacea (L.) Benth. & Hooker

A white-tomentose or woolly perennial herb, the erect leafy stem corymbosely branched at the summit, 1–3 feet high. The alternate, entire leaves linear-lanceolate, sessile, revolute, green but pubescent above and woolly beneath, 3–5 inches long, heads of flowers numerous in a compound corymb, 2–8 inches broad, each head one-quarter to one-third inch broad when expanded; involucre campanulate, its bracts ovate-lanceolate, obtuse, pearly white; flowers cream-colored becoming yellowish; staminate flowers with a slender or filiform corolla, an undivided style and pappus bristles not thickened at the summit or scarcely so; pistillate flowers with a tubular 5-toothed corolla, 2-cleft style and a pappus of distinct capillary bristles which fall away separately.

Rather common in dry soil, especially on abandoned fields, old pastures, roadsides and door yards, and open woods from Newfoundland to Alaska, Pennsylvania, Kansas and Oregon. Flowering from August to October.

The dry chaffy character of the involucre of the flowers suggests the appropriate name of everlasting. Clusters may be gathered and placed in a vase or other receptacle without water and kept for an indefinite length of time. They are sometimes subjected to various dyes but it is doubtful if this adds anything to their attractiveness. In florists shops they are frequently seen dyed a brilliant red.

Pearly Everlasting (Compositæ)
Anaphalis margaritacæ (Linn.) Benth. & Hooker

Plate 2

PALE TOUCH-ME-NOT

(Balsaminaceae)

Impatiens pallida Nuttall

A tall, stout, annual herbaceous plant with rather succulent stems and alternate, simple, dentate and petioled, thin, ovate to elliptic leaves, pale and somewhat glaucous beneath, 1–4 inches long; flowers showy, pale yellow, 1–1½ inches long on axillary peduncles, irregular, sparingly dotted with reddish brown or sometimes without spots, sepals 3, the 2 lateral ones small, green, nerved, the posterior one large, petaloid, and forming the conspicuous sac which terminates in a short spreading spur; petals 3, with 2 of them 2-cleft into dissimilar lobes; stamens 5, short; filaments appendaged by scales on their inner side and more or less united; gruit an oblong or linear capsule, elastically and violently dihiscent at the slightest touch when mature into 5 spirally coiled valves, expelling the oblong, ridged seeds; small and inconspicuous cleistogamous flowers without petals are frequently developed following the petaliferous flowers.

In moist grounds, most frequent in shaded situations along streams and springy places in woods, Nova Scotia to Saskatchewan, Georgia and Kansas. Apparently not so abundant as the spotted touch-me-not which possesses orange-yellow flowers. Flowering from July to September.

The rapidity with which the flowers and leaves of the wild touch-me-nots wither prevents its use as an ornamental cutflower species although its relative, the balsam or garden touch-me-not, with purple or white flowers, is frequent in cultivation. This species is also known as the pale or yellow jewelweed.

Pale Touch-Me-Not (Balsaminaceæ)

Impatiens pallida Nuttall

Plate 3

III

WINTERGREEN

(Ericaceae)

Gaultheria procumbens L.

A low, aromatic, semi-woody plant with creeping or subterranean, perennial stems, branches erect or nearly so, 2–6 inches high, bearing several oval, oblong or obovate, obtuse or acute, thick, evergreen leaves, dark green and shining above, pale beneath, 1–2 inches long, margins slightly revolute and serrate with low bristle-tipped teeth; flowers white, usually solitary in the axils of the leaves, on recurved peduncles; corolla ovoid-urceolate, with 5 recurved teeth. Stamens 10, included and inserted at base of the corolla, the anther sacs opening by a terminal pore; fruit depressed-globose, usually slightly 5-lobed, bright red when mature, one-third to one-half inch in diameter, mealy and very spicy in flavor.

In woods and open places, especially under or near evergreen trees, most abundant in sandy regions, Newfoundland to Manitoba, New Jersey, Georgia, West Virginia, Indiana and Michigan. Flowering from June to early September, the fruit ripe in late autumn and persisting on the branches well into the next season.

The generic name was given to this plant by Peter Kalm in honor of Doctor Gaultier who lived at Quebec in the middle of the eighteenth century.

Wintergreen (Ericaceæ)

Gaultheria procumbens Linn.

Plate 4

INDIAN PIPE

(Ericaceae)

Monotropa uniflora Linn.

A white, scapose, succulent plant growing usually in clusters from a mass of matted, brittle roots, attached to partially decayed organic matter in the soil, stems 4–10 inches high, erect, each with a solitary nodding, terminal, inodorous, oblong-campanulate flower, one-half to 1 inch long; the fruit, which is a 5-celled, many-seeded capsule becoming erect; sepals 2–4, deciduous; petals 4–5 (rarely 6), puberulent within, white, somewhat longer than the stamens which are usually ten in number; ovary ovoid, acute, narrowed into the short, thick style and funnelform stigma.

In moist, rich woods, Anticosti to Florida, west to Washington and California.

The Indian pipe or corpse-plant, as it is frequently known, is one of the few flowering plants which possesses a saprophytic habit, and is in consequence devoid of green leaves or green color in the stems.

Indian Pipe (Ericaceæ)

Monotropa uniflora Linn.

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Appendix 5

Archeology

Museum Bulletin 184

184 The Constitution of the Five Nations

New York State Museum Bulletin

Application pending for admission as second-class matter at the Post Office at Albany, N. Y. under the act of August 24, 1912

Published monthly by The University of the State of New York

No. 184 ALBANY, N. Y. APRIL 1, 1916

The University of the State of New York

New York State Museum

JOHN M. CLARKE, Director

THE CONSTITUTION OF THE FIVE NATIONS

BY

ARTHUR C. PARKER

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The University of the State of New York
Science Department, July 12, 1915

Dr John H. Finley
President of the University

SIR: I beg to communicate to you herewith and to recommend for publication as a bulletin of the State Museum, a manuscript with accompanying illustrations, entitled *The Constitution of the Five Nations,* which has been prepared by Arthur C. Parker, the Archeologist of the State Museum.

Very respectfully
JOHN M. CLARKE
Director

THE UNIVERSITY OF THE STATE OF NEW YORK
OFFICE OF THE PRESIDENT

Approved for publication this 15th day of March 1915

President of the University

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THE CONSTITUTION OF THE FIVE NATIONS

OR

THE IROQUOIS BOOK OF THE GREAT LAW

BY

ARTHUR C. PARKER

THE IROQUOIS CONSTITUTION

The constitution of the Iroquois League is known to the Iroquois as the Great Binding Law, or the Great Immutable Law. Their term for it is Ne" Gayänĕshä"gowā. It was transmitted orally from one generation to another through certain of the lords or sachems of the confederacy who had made it their business to learn it. Not until recently have the Iroquois attempted to put their code in written form. For many generations its knowledge has been preserved by a collection of wampum belts and strings, each of which served to recall each law or regulation. Many of the belts and strings became lost or destroyed, and fearing a total destruction of their ancient archives, the Six Nations[1] of New York Indians in 1898 elected The University of the State of New York the official custodian of their wampums. The University accepted the charge and the Legislature passed suitable laws governing the custody of the wampums. In 1908 the Director of the State Museum was proclaimed the keeper of the wampums by Sa-ha-whi, president of the Six Nations.

[1] The Five Nations became the Six Nations, with the admission of the Tuscarora in 1724.

Plate 1

MAP OF THE CENTRAL PORTION OF NEW YORK

THE LONG HOUSE COUNTRY

This area covers the principal region traversed by Dekanawida and Hiawatha in their efforts to effect the formation of the Five Nations' Confederacy. The dotted lines from Onondaga lake through the Mohawk valley shows approximately the route taken by Hiawatha in his journey to meet Dekanawida.

The Iroquois constitution is mentioned by both Morgan and Hale, but neither seems to have been able to make a transcript and translation of it. All the Iroquois nations were acquainted with it and extracts from the law are found in many of the speeches of their sachems, as recorded by historians, notably the French explorers and Colden.

The version of the constitution now held authentic by the Iroquois of New York and Ontario, embraces a narrative of the events in the lives of Hiawatha and Dekanawida that lead up to its foundation. Its special interest lies in the fact that it is an attempt of the Iroquois themselves to explain their own civic and social system. It is therefore an invaluable guide to many interesting branches of Iroquois ethnology. Many of the facts contained in this document are familiar to students, but that they formed a part of a definite system of law will perhaps be new. Several of the wampum belts in the New York State Museum are constitutional belts or memorials.

Originally the Five Nations of Iroquois were similar to other Indian tribes or bands — independent bodies with similar dialects and similar customs but with no political coherence. Each man and each tribe to itself, was the rule. Often the individual nations warred with one another, and with external enemies pressing them from all quarters they found themselves in a precarious situation. The very peril in which they lived developed their strategic ability and fostered diplomacy. It likewise produced leaders and finally the great lawgiver who should bring about peace and unity and make the Iroquois the " Indians of Indian," the " Romans of the New World." Hale referred to Hiawatha as the " lawgiver of the Stone age "[1] but Hiawatha does not deserve the title. He was only the spokesman of a greater mind. The Mohawk nation recognizes in Dekanawida its great culture hero and the founder of its civic system, giving Haiyentwatha (Hiawatha) a second place. Nearly all authorities among the other nations of the five agree in this and attribute to Dekanawida the establishment of the Great Peace. The prefatory articles of the Great Immutable Law recognize him as such and represent him as saying:

> I am Dekanawideh and with the Five Nations' confederate lords I plant the Tree of the Great Peace. I plant it in your territory Adodarhoh and the Onondaga Nation, in the territory of you who are fire keepers.
>
> I name the tree the Tree of the Great Long Leaves. Under the shade of this Tree of the Great Peace we spread the soft, white, feathery down of the globe thistle as seats for you, Adodarhoh and your cousin lords.

[1] Proc. Amer. Ass'n. Adv. Sci., 30:324. 1881.

> . . . There shall you sit and watch the council fire of the Confederacy of the Five Nations.
>
> Roots have spread out from the Tree of the Great Peace . . . and the name of these roots is the Great White Roots of Peace. If any man of any nation outside of the Five Nations shall show a desire to obey the laws of the Great Peace . . . they may trace the roots to their source . . . and they shall be welcomed to take shelter beneath the Tree of the Long Leaves.
>
> The smoke of the confederate council fire shall ever ascend and shall pierce the sky so that all nations may discover the central council fire of the Great Peace.
>
> I, Dekanawideh, and the confederate lords now uproot the tallest pine tree and into the cavity thereby made we cast all weapons of war. Into the depths of the earth, down into the deep underearth currents of water flowing into unknown regions, we cast all weapons of strife. We bury them from sight forever and plant again the tree. Thus shall all Great Peace be established and hostilities shall no longer be known between the Five Nations but only peace to a united people.

As one goes further into the unique document, the method by which universal peace is to be established is revealed. All nations were to sit beneath the peace tree and acknowledge the imperial regency of the Five Nations' council. To the Five Nations this seemed a very simple thing for they called themselves Ongweoweh, Original Men, a term that implied their racial superiority. Thus to them it seemed quite natural that other nations should acknowledge their right to rule. They never doubted the justness of their claim or saw that it possibly could be disputed. With them it was the basis for universal action. Other nations were inclined to dispute that the Iroquois were inherently superior and naturally rebelled at the idea of submission, even though it might be for their own ultimate benefit.

From tribe to tribe, tradition shows,[1] the emissaries of the Great Peace went carrying with them the messages in their wampum strands, and inviting delegates to sit beneath the Peace Tree and "clasp their arms about it" and to discuss the advantages of an alliance.

The political success of the Iroquois as a result of their system gave them phenomenal strength and likewise excited widespread jealousy. Thus the Iroquois found themselves plunged in a war for existence and without friends to call upon.

How a government calling itself the Great Peace provided for war is shown in the part of the great immutable law called "Skanawatih's Laws of Peace and War." Extracts from these laws follow:

> When the proposition to establish the Great Peace is made to a foreign nation it shall be done in mutual council. The nation is to be persuaded

[1] See, for example, The Passamaquoddy Wampum Records by J. D. Prince, page 483, Proc. Amer. Phil. Soc., v. 36. Also Appendix, page 119 of this bulletin.

by reason and urged to come into the Great Peace. If the Five Nations fail . . . after a third council . . . the war captain of the Five Nations shall address the head chief of the rebellious nation and request him three times to accept the Great Peace. If refusal steadfastly follows the war captain shall let a bunch of white lake shells fall from his outstretched hand and shall bound quickly forward and club the offending chief to death. War shall thereby be declared and the war captain shall have his men at his back to support him in any emergency. War shall continue until won by the Five Nations. . . . Then shall the Five Nations seek to establish the Great Peace by a conquest of the rebellious nation.

When peace shall have been established by the termination of the war . . . then the war captain shall cause all weapons of war to be taken from the nation. Then shall the Great Peace be established and the nation shall observe all the rules of the Great Peace for all time to come.

Whenever a foreign nation is conquered or has by their own free will accepted the Great Peace, their own system of internal government may continue so far as is consistent but they must cease all strife with other nations.

In this manner and under these provisions and others every rebellious tribe or nation, almost without exception, was either exterminated or absorbed. The Erie, the Neutral, the Huron, the Andaste and other cognate tribes of the Iroquoian stock were broken up and the scattered bands or survivors settled in the numerous Iroquois towns to forget in time their birth nation and to be known forever after only as Iroquois. The law read, " Henceforth let no one so adopted mention the name of his birth nation. To do so will hasten the end of the Great Peace." The Lenni Lenape or Delaware, the Nanticoke, the broken bands of the Minsi and the Shawne, the Brothertown and other Algonquian tribes yielded to the armed persuasions to accept the Great Peace; likewise did the Tutelo and Catawba of the eastern Siouan stock, and the Choctaw of the Muskoghean yield, and to that action is due the fact that they have descendants today.

The Iroquois policy of adopting captives led to the mixture of widely scattered stocks. The Iroquois therefore became an ethnic group of composite elements. Thus from the ideas of universal peace and brotherhood grew universal intermarriage, modified of course by clan laws.

According to the great immutable law the Iroquois confederate council was to consist of fifty rodiyaner (civil chiefs) and was to be divided into three bodies, namely, the older brothers, the Mohawk and the Seneca; the younger brothers, the Cayuga and the Oneida; and the fire keepers, the Onondaga. Each brotherhood debated a question separately and reported to the fire keepers, who referred the matter back and ordered a unanimous report. If the two brotherhoods still disagreed the fire keepers had the casting vote.

If, however, the brotherhoods agreed and their decision was not in accord with the wishes of the fire keepers, the fire keepers could only confirm the decision, for absolute unanimity was the law and required for the passage of any question. Provisions to break speedily any deadlock were provided. All the work of the council was done without an executive head, save a temporary speaker appointed by acclamation. Adodarhoh, in spite of his high title, was only the moderator of the fire keepers.

These "lords" or civil chiefs were nominated by certain noble women in whose families the titles were hereditary; the nominations were confirmed by popular councils both of men and of women and finally by the confederate council. Women thus had great power for not only could they nominate their rulers but also depose them for incompetency in office. Here, then, we find the right of popular nomination, the right of recall and of woman suffrage, all flourishing in the old America of the Red Man and centuries before it became the clamor of the new America of the white invader. Who now shall call Indians and Iroquois savages!

Not only were there popular councils to check an overambitious government, but both the men and the women had in their "war chief" a sort of aboriginal public service commissioner who had authority to voice their will before the council. Men of worth who had won their way into the hearts of the people were elected pine tree chiefs with voice but no vote in the governing body. The rights of every man were provided for and all things done for the promotion of the Great Peace.

Among the interesting things in this Iroquois constitution are the provisions for the official symbols. Many of these symbols, such as the point within a circle, the bundle of arrows, the watchful eagle, are described in detail. The fifteenth string of the Tree of the Long Leaves section, for example, reads:

"Five arrows shall be bound together very strongly and each arrow shall represent one nation. As the five arrows are strongly bound, this shall symbolize the union of the nations. . . ."

This reference to the arrows bound together was quoted by King Hendrick in 1755 in his talk with Sir William Johnson.

Perhaps a more striking paragraph to students of Indian history will be the reference to a certain wampum belt:

"A broad, dark belt of wampum . . . having a white heart in the center on either side of which are two white squares all connected with the heart by white rows shall be the emblem of the unity of the Five Nations. The white heart in the middle . . .

means the Onondaga nation . . . and it also means that the heart of the Five Nations is single in its loyalty to the Great Peace. . . ."

This belt is sometimes called the Hiawatha belt and is one of the most valuable Iroquois belts now extant. It is now on exhibition in the Congressional Library.

The Great Peace as a governmental system was an almost ideal one for the stage of culture with which it was designed to cope. I think it will be found to be the greatest ever devised by barbaric man on any continent. By adhering to it the Five Nations became the dominant native power east of the Mississippi and during the colonial times exercised an immense influence in determining the fate of English civilization on the continent. They, as allies of the British, fought for it and destroyed all French hopes for colonization.

The authors of the great immutable law gave the Iroquois two great culture heroes, heroes almost without equal in American Indian annals. Through the law as a guiding force and through the heroes as ideals the Iroquois have persisted as a people, preserved their national identity and much of their native culture and lore. Today in their various bodies they number more than 16,000 souls. This is a remarkable fact when it is considered that they are entirely surrounded by a dominant culture whose encroachments are persistent and unrelenting in the very nature of things.

The Canadian Iroquois indeed govern themselves by the laws contained in these codes, proving their utility even in modern days.

The two principal manuscripts that form the basis of this work were found in the Six Nations Reservation, Ontario, Canada, in 1910.

The first manuscript was a lengthy account of the Dekanawida legend and an account of the Confederate Iroquois laws. This material has been brought together by Seth Newhouse, a Mohawk, who has expended a large amount of time and given the subject a lengthy study. His account written in Indian English was submitted to Albert Cusick, a New York Onondaga-Tuscarora, for review and criticism. Mr Cusick had long been an authority on Iroquois law and civic rites, and had been a chief informant for Horatio Hale, William M. Beauchamp and in several instances for the present writer. Mr Cusick was employed for more than a month in correcting the Newhouse manuscript until he believed the form in which it is now presented fairly correct and at least as accurate as a free translation could be made.

The second manuscript was compiled by the chiefs of the Six Nations council and in the form here published has been reviewed and corrected by several of their own number, including Chiefs John Gibson, Jacob Johnson and John William Elliott. The official copy was made by Hilton Hill, a Seneca, then employed by the Dominion superintendent for the Six Nations. It has been reviewed and changes were suggested by Albert Cusick.

The Newhouse code was divided into three sections. These were, "The Tree of the Long Leaves," "The Emblematical Union Compact," and "Skanawatih's Law of Peace and War." Each law was associated with a wampum belt or string of wampum beads. The string number and the section of the code from which it is extracted is indicated after each law, as given in the text.

In examining this code of Iroquois law it will be noted that no reference is made in the Canadian codes to the "Long House of the Five Nations." Various reasons are assigned for this. Mr Newhouse cut out all reference to it from his original manuscript because some of the older chiefs said that Handsome Lake, the destroyer of the old religious system, had successfully associated his religious teachings with the Long House. The force of this fact is apparent when we learn that a follower of the Handsome Lake religion is called among other names, Gānūñ'sisnē'ha, "Long House Lover." Another reason is that the historic Long House territory is in New York State, and that the Ontario Iroquois who left New York after the Revolution to cling to the British, dislike any reference to their former habitation that seems to bind them to it. The Dekanawida code provides a refuge for the confederacy in distress, and in Canada they believe they have found "the great elm" under which they may gather in safety to continue their national existence.

In presenting these documents the original orthography has been retained. The only attempt to record Iroquois names and words phonetically is in the notes. This will account for some variations in spelling. The Mohawk and Onondaga writers in their manuscripts used Ayonhwatha and Hayonhwatha interchangeably and there are other variations.

THE DEKANAWIDA LEGEND[1]

DEKANAWIDA'S BIRTH AND JOURNEY

North of the beautiful lake (Ontario) in the land of the Crooked Tongues, was a long winding bay and at a certain spot was the Huron town, Ka-ha-nah-yenh. Near by was the great hill, Ti-ro-nat-ha-ra-da-donh. In the village lived a good woman who had a virgin daughter. Now strangely this virgin conceived and her mother knew that she was about to bear a child. The daughter about this time went into a long sleep and dreamed that her child should be a son whom she should name Dekanawida. The messenger in the dream told her that he should become a great man and that he should go among the Flint people to live and that he should also go to the Many Hill Nation and there raise up the Great Tree of Peace. It was true as had been said the virgin gave birth to a boy and the grandmother greatly disliked him and she rebuked her daughter.

"You refuse to tell me the father of the child," she said, "and now how do you know that great calamity will not befall us, and our nation? You must drown the child."

So then the mother took the child to the bay and chopped a hole in the ice where she customarily drew water and thrust him in, but when night came the child was found at his mother's bosom. So then the mother took the child again and threw him in the bay but at night the child returned. Then the third time the grandmother herself took the child and drowned him but in the morning the child nestled as before on its mother's own bosom.

So the grandmother marveled that the child, her grandson, could not be drowned. Then she said to her daughter:

"Mother, now nurse your child for he may become an important man. He can not be drowned, we know, and you have borne him without having marriage with any man. Now I have never heard of such an occurrence nor has the world known of it before."

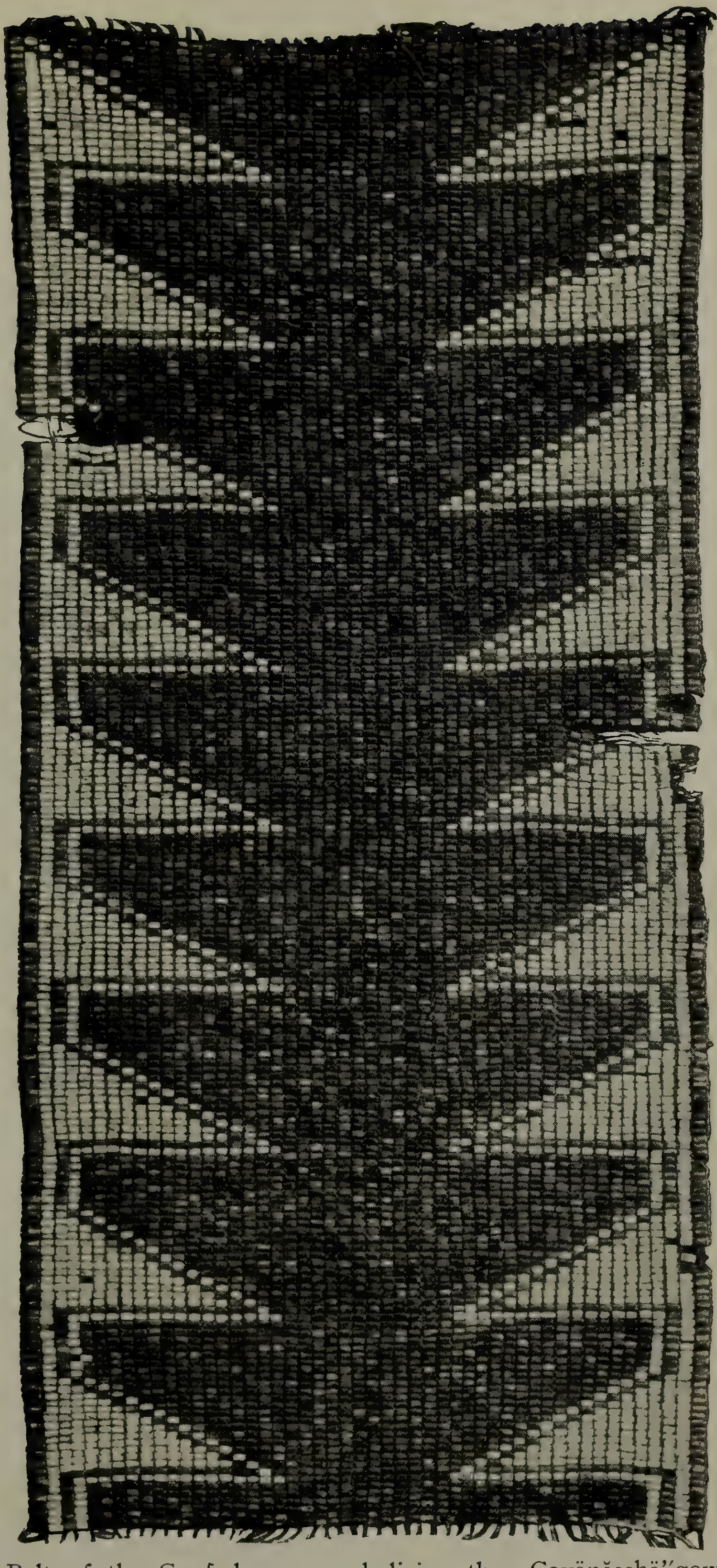
Beginning with that time the mother took great care of her child and nursed him. She named him Dekanawida in accord with the instruction of her dream.

The child rapidly grew and was remarkably strong and healthy. His appearance was noticed for its good aspect and his face was most handsome.

When Dekanawida had grown to manhood he was greatly abused

[1] From the Newhouse version.

Plate 2



Great Belt of the Confederacy symbolizing the Gayänĕsshä''gowā as an ever growing tree

by the Huron people because of his handsome face and his good mind. He was always honest and always told what he believed was right. Nevertheless he was a peculiar man and his people did not understand him.

Many things conspired to drive him away for the Crooked Tongues had no love for such a man. Their hearts were bitter against a man who loved not war better than all things.

After a journey by canoe across the lake he came into the hunting territory of the Flint Nation. He journeyed on to the lower fall of the river of the Flint Nation and made a camp a short way from the fall on the flat land above it. He sat beneath a tall tree and smoked his pipe in quiet meditation.

A man of the Flints passed by and seeing the fire and the stranger approached him cautiously to discover what weapon he bore, if any. Carefully the man of the Flint reconnoitered but saw no weapon, but only the stranger quietly smoking. Returning to the town a short distance away the presence of the odd stranger was reported. Then the chiefs and their men went out and assembled about the man who smoked. One of the head men was delegated to question the stranger and so he asked " From whence came you?"

" I am from Ka-ka-na-yenh," the stranger replied.

" I am of the Wyandots, whom you call the Crooked Tongues because our speech is slightly different," answered the stranger, " My mother is a virgin woman."

" Then," said the speaker, " By what name are you known?"

" I am Dekanawidah, so named because my virgin mother dreamed that it should be so and no one else shall ever be named by this name."

" What brought you here to us," asked the speaker.

So then Dekanawidah answered, " The Great Creator from whom we all are descended sent me to establish the Great Peace among you. No longer shall you kill one another and nations shall cease warring upon each other. Such things are entirely evil and he, your Maker, forbids it. Peace and comfort are better than war and misery for a nation's welfare."

Then answered the speaker of the Flints, "All that you say is surely true and we are not able to contradict it. We must have proof, however, before we submit ourselves to you whereby we may know that you indeed possess rightful power to establish the Great Peace."

So answered Dekanawida, " I am able to demonstrate my power for I am the messenger of the Creator and he truly has given me my choice of the manner of my death."

" Choose then," said the speaker, " a manner of destruction for we are ready to destroy you." Dekanawida replied, " By the side of the falls at the edge of a precipice stands a tall tree. I will climb the tree and seat myself in the topmost branches. Then shall you cut down the tree and I shall fall into the depths below. Will not that destroy me?"

Then said the speaker, " Let us proceed at once."

Dekanawida ascended the tree and it was chopped down. A multitude of people saw him fall into the chasm and plunge into the water. So they were satisfied that he was surely drowned. Night came but Dekanawida did not appear and thus were the people sure of his death, and then were they satisfied.

The next morning the warriors saw strange smoke arising from the smoke hole of an empty cabin. They approached cautiously and peering in the side of the wall where the bark was loosened they saw Dekanawidah. He was alive and was not a ghost and he was cooking his morning meal.

So the watchers reported their discovery and then were the chiefs and people truly convinced that indeed Dekanawidah might establish the Great Peace.

THE TROUBLED NATIONS

The Ongwe-oweh had fought long and bravely. So long had they fought that they became lustful for war and many times Endeka-Gakwa, the Sun, came out of the east to find them fighting. It was thus because the Ongwe-oweh were so successful that they said the Sun loved war and gave them power.

All the Ongwe-oweh fought other nations sometimes together and sometimes singly and, ah-gi! ofttimes they fought among themselves. The nation of the Flint had little sympathy for the Nation of the Great Hill, and sometimes they raided one another's settlements. Thus did brothers and Ongwe-oweh fight. The nation of the Sunken Pole fought the Nation of the Flint and hated them, and the Nation of the Sunken Pole was Ongwe.

Because of bitter jealousy and love of bloodshed sometimes towns would send their young men against the young men of another town to practise them in fighting.

Even in his own town a warrior's own neighbor might be his enemy and it was not safe to roam about at night when Soi-ka-Gakwa, our Grandmother, the Moon, was hidden.

Everywhere there was peril and everywhere mourning. Men were ragged with sacrifice and the women scarred with the flints, so everywhere there was misery. Feuds with outer nations, feuds with brother nations, feuds of sister towns and feuds of families and of clans made every warrior a stealthy man who liked to kill.

Then in those days there was no great law. Our founder had not yet come to create peace and give united strength to the Real Men, the Ongwe-oweh.

In those same days the Onondagas had no peace. A man's life was valued as nothing. For any slight offence a man or woman was killed by his enemy and in this manner feuds started between families and clans. At night none dared leave their doorways lest they be struck down by an enemy's war club. Such was the condition when there was no Great Law.

South of the Onondaga town lived an evil-minded man. His lodge was in a swale and his nest was made of bulrushes. His body was distorted by seven crooks and his long tangled locks were adorned by writhing living serpents. Moreover, this monster was a devourer of raw meat, even of human flesh. He was also a master of wizardry and by his magic he destroyed men but he could not be destroyed. Adodarhoh was the name of the evil man.

Notwithstanding the evil character of Adadarhoh the people of Onondaga, the Nation of Many Hills, obeyed his commands and though it cost many lives they satisfied his insane whims, so much did they fear him for his sorcery.

The time came, however, when the Onondaga people could endure him no longer. A council was called to devise a way to pacify him and to entreat him to cease his evil ways. Hayonwatha called the council for he had many times sought to clear the mind of Adodarhoh and straighten his crooked body. So then the council was held in the house of Hayontawatha. It was decided that half the people should go by boat across the creek where it widens and that others should skirt the shore. Adodarhoh was not in his nest in the swale but in a new spot across the wide place in the creek.

The boats started and the people walked. From the bushes that overhung the shore a loud voice sounded. "Stand quickly and look behind you for a storm will overwhelm you."

In dismay the people arose in their canoes and turned about. As they did so the canoes overturned and the men were plunged into the water and many were drowned. A few escaped and then all survivors returned to the village. So had Adodarhoh frustrated the attempt to meet with him.

Again the people prepared to conciliate Adodarho. Three times they agreed to attempt the undertaking. So on the second occasion they go by canoe and by land, those who go by canoe follow the shore and those who go by land walk on the pebbles close to the water's edge.

Again the cunning Adodarho sees them and calling down Hagoks he shook him, and the people in a wild rush scramble for the feathers, for the plumes of Hagoks are most beautiful and men are proud when their heads are adorned with them. There is a tumult and blows are struck. Evil feelings arise and in anger the people return to the village still contending. The mission of conciliation is forgotten.

The next day Ayonhwatha called the people to their promise and for the third time to attempt a council with Adodarho. Moreover, they promised to obey every instruction and listen neither to a voice outside nor an omen nor any commotion.

Another council was held in the lodge of a certain great dreamer. He said, " I have dreamed that another shall prevail. He shall come from the north and pass to the east. Hayonwhatha shall meet him there in the Mohawk country and the two together shall prevail. Hayonwhatha must not remain with us but must go from us to the Flint land people."

So when the journey across the lake was attempted there was a division and the dreamer's council prevailed.

Then the dreamer held two councils and those who believed in him conspired to employ Ohsinoh, a famous shaman.

Hayonwhatha had seven daughters whom he loved and in whom he took great pride. While they lived the conspirators knew he would not depart. With the daughters dead they knew the crushing sorrow would sever every tie that bound him to Onondaga. Then would he be free to leave and in thinking of the welfare of the people forget his own sorrow.

Hayonwhatha could not call the people together for they refused further to listen to his voice. The dreamer's council had prevailed.

At night Osinoh climbed a tree overlooking his lodge and sat on a large limb. Filling his mouth with clay he imitated the sound of a screech owl. Calling the name of the youngest daughter he sang:

" Unless you marry Osinoh
You will surely die, -whoo-hoo!"

Then he came down and went to his own home.

In three days the maiden strangely died. Hayonwhatha was disconsolate and sat sitting with his head bowed in his hands. He mourned, but none came to comfort him.

In like manner five other daughters passed away and the grief of Hayonwhatha was extreme.

Clansmen of the daughters then went to the lodge of Hayonwhatha to watch, for they knew nothing of Osinoh's sorcery. They gathered close against the large trees and in the shadows of bushes. The clansmen suspected some evil treachery and were there to discover it.

There was no moon in the sky when Osinoh came. Cautiously he came from habit but he was not afraid. He drove his staff in the ground, he breathed loud like a magic totem animal snorting and then he climbed the tree. He spat the clay about the tree to imitate the screech owl and as he did he said: "Si-twit, si-twit, si-twit." Then he sang:

> "Unless you marry Osinoh
> You shall surely die, whoo-hoo!"

The morning came and Osinoh descended. As he touched the ground a clansman shot an arrow and transfixed him. Prostrate fell Osinoh and the clansman rushed at him with a club.

Osinoh looked up. "You are unable to club me," he said. "Your arm has no power at all. It weakens. Today I shall recover from this wound. It is of no purpose to injure me."

It was true indeed; the clansman could not lift the club to kill Osinoh. Then Osinoh arose and went home and in three days the daughter died. So perished all by the evil magic arts of Osinoh.

The grief of Hayonwhatha was terrible. He threw himself about as if tortured and yielding to the pain. No one came near him so awful was his sorrow. Nothing would console him and his mind was shadowed with the thoughts of his heavy sorrow.

"I shall cast myself away, I shall bury myself in the forest, I shall become a woodland wanderer," he said. Thus he expressed his desire to depart. Then it was known that he would go to another nation.

Hayonwhatha "split the heavens," Watanwhakacia, when he departed and his skies were rent asunder.

Toward the south he went and at night he camped on the mountain. This was the first day of his journey. On the second day he descended and camped at the base of the hill. On the third day

he journeyed onward and when evening came he camped in a hickory grove. This he named O-nea-no-ka-res-geh, and it was on the morning he came to a place where round jointed rushes grew. He paused as he saw them and made three strings of them and when he had built a fire he said: "This would I do if I found anyone burdened with grief even as I am. I would console them for they would be covered with night and wrapped in darkness. This would I lift with words of condolence and these strands of beads would become words with which I would address them."

So at this place he stayed that night and he called the spot O-hon-do-gon-wa, meaning Rush-land.

When daylight came he wandered on again and altering the course of his journey turned to the east. At night he came to a group of small lakes and upon one he saw a flock of ducks. So many were there and so closely together did they swim that they seemed like a raft.

"If I am to be truly royaneh (noble)," he said aloud to himself, "I shall here discover my power." So then he spoke aloud and said: "Oh you who are 'floats' lift up the water and permit me to pass over the bottom of the lake dryshod."

In a compact body the ducks flew upward suddenly and swiftly, lifting the water with them. Thus did he walk down the shore and upon the bottom of the lake. There he noticed lying in layers the empty shells of the water snail, some shells white, and others purple. Stooping down he filled a pouch of deer skin with them, and then passed on to the other shore. Then did the ducks descend and replace the water.

It was here that Hayonwhatha desired for the first time to eat. He then killed three ducks and roasted them. This was the evening of the fifth day.

In the morning he ate the cold meat of the roasted ducks and resumed his journey. This was the sixth day and on that day he hunted for small game and slept.

On the morning of the seventh day he ate again and turned his way to the south. Late in the evening he came to a clearing and found a bark field hut. There he found a shelter and there he erected two poles, placed another across the tops and suspended three shell strings. Looking at them he said: "Men boast what they would do in extremity but they do not do what they say. If I should see anyone in deep grief I would remove these shell strings from the pole and console them. The strings would become words and lift away the darkness with which they are covered. Moreover what I say I would surely do." This he repeated.

A little girl discovered smoke arising from the field lodge and she crept up and listened. She advanced and peered in a chink in the bark. Then she ran homeward and told her father of the strange man.

"The stranger must be Hayonwhatha," said the father, "I have heard that he has departed from Onondaga. Return, my daughter, and invite him to our house."

The girl-child obeyed and Hayonwhatha went to her house. "We are about to hold a council," the father said. "Sit in that place on one side of the fire and I will acquaint you with our decisions."

The council was convened and there was a great discussion. Before darkness every evening the council dissolved and at no time was Hayonwhatha called upon for advice nor was anything officially reported to him.

On the tenth day of his journey during the debate in the council Hayonwhatha quietly left and resumed his wandering. Nothing had been asked of him and he felt himself not needed by the people. Late in the evening he came to the edge of another settlement and as was his custom he kindled a fire and erected a horizontal pole on two upright poles. On this he placed three strings of the wampum shells. Then he sat down and repeated his saying: "Men boast what they would do in extremity but they do not do what they promise. If I should see any one in deep grief I would remove these shells from this pole and console him. The shells would become words and lift away the darkness with which they are covered. Moreover, I truly would do as I say." This he repeated.

The chief man of the village saw the smoke at the edge of the forest and sent a messenger to discover who the stranger might be. Now when the messenger reached the spot he saw a man seated before a fire and a horizontal pole from which three strings of small shells were suspended. He also heard the words spoken as the stranger looked at the strings. So then when he had seen all he returned and reported what he had seen and heard.

Then said the chief man, "The person whom you describe must truly be Hayonwhatha whom we have heard left his home at Onondaga. He it is who shall meet the great man foretold by the dreamer. We have heard that this man should work with the man who talks of the establishment of peace."

So then the chiefs sent a messenger who should say, "Our principal chief sent me to greet you. Now then I wish you would come into our village with me."

Hayonwhatha heard the messenger and gathered up his goods and went into the village and when he had entered the chief's house the chief said, " Seat yourself on the opposite side of the fire so that you may have an understanding of all that we do here in this place."

Then Hayonhwatha sat there for seven days and the chiefs and people talked without arriving at any decision. No word was asked Hayonhwatha and he was not consulted. No report was made officially to him. So he did not hear what they talked about.

On the eighteenth night a runner came from the south. He was from the nation residing on the seashore. He told the chiefs of the eminent man who had now come to the town on the Mohawk river at the lower falls. Then the messenger said: " We have heard of the dream of Onodaga which told of the great man who came from the north. Now another great man who shall now go forward in haste to meet him shall change his course and go eastward to meet in the Flinty land village (Kanyakahake), the great man. There shall the two council together and establish the Great Peace." So said the messenger from the salt water seashore, who came to tell Hayonwhatha to journey east.

So the chiefs of the town where Hayonhwatha was staying chose five men as an escort for Hayonhwatha. They must go with him until he reached the house where Dekanawida was present. So then on the next day the chief himself went with the party and watched carefully the health of Hayonhwatha. The journey lasted five days and on the fifth day the party stopped on the outskirts of the town where Dekanawida was staying and then they built a fire. This was the custom, to make a smoke so that the town might know that visitors were approaching and send word that they might enter without danger to their lives. The smoke was the signal of friends approaching.[1] The Mohawks (People of the Flinty Country) knew the meaning of the signal so they sent messengers and invited the party into the village.

When Hayonhwatha had entered the house where the people had gathered the chief asked him whom he would like to see most. Then Ayonhwatha answered, " I came to see a very great man who lately came from the north." The chief said, " I have with you two men who shall escort you to the house where Dekanawida is

[1] In those days it was necessary to build a fire on the outskirts of a village about to be entered. If necessary to kill an animal for food, its pelt must be hung on a tree in plain sight because it is the property of the nation in whose territory it is killed. This information was given to me by Albert Cusick and Seth Newhouse.

present." Then the people went out and the two men escorted Hayonhwatha to Dekanawida. This was on the twenty-third day. Then Dekanawida arose when Hayonhwatha had entered and he said: "My younger brother I perceive that you have suffered from some deep grief. You are a chief among your people and yet you are wandering about."

Hayonhwatha answered, "That person skilled in sorcery, Osinoh, has destroyed my family of seven daughters. It was truly a great calamity and I am now very miserable. My sorrow and my rage have been bitter. I can only rove about since now I have cast myself away from my people. I am only a wanderer. I split the heavens when I went away from my house and my nation."

Dekanawida replied, "Dwell here with me. I will represent your sorrow to the people here dwelling."

So Hayonhwatha had found some one who considered his distress and he did stay. Then Dekanawida told of his suffering and the people listened.

The five escorts were then dismissed and Hayonhwatha gave thanks to them and told them to return to their own region again. Then the escorts said, "Now today it has happened as was foretold in a dream. The two are now together. Let them now arrange the Great Peace." Then they returned home.

When Dekanawida laid the trouble before the council he promised to let Hayonhwatha know their decision. The chiefs deliberated over the sad events and then decided to do as Dekanawida should say. He then should remedy the trouble. Then Dekanawida went in perplexity to his lodge and as he came to it he heard Hayonhwatha say, "It is useless, for the people only boast what they will do, saying 'I would do this way,' but they do nothing at all. If what has befallen me should happen to them I would take down the three shell strings from the upright pole and I would address them and I would console them because they would be covered by heavy darkness." Dekanawida stood outside the door and heard all these words. So then Dekanawida went forward into the house and he went up to the pole, then he said: "My younger brother, it has now become very plain to my eyes that your sorrow must be removed. Your griefs and your rage have been great. I shall now undertake to remove your sorrow so that your mind may be rested. Have you no more shell strings on your pole?"

Hayonhwatha replied, "I have no more strings but I have many shells in a tanned deer's skin." So he opened his bundle and a great

quantity of shells fell out. So then Dekanawida said, " My younger brother, I shall string eight more strands because there must be eight parts to my address to you." So then Hayonhwatha permitted the stringing of the shells and Dekanawida made the strings so that in all there were thirteen strings and bound them in four bunches. These must be used to console the one who has lost by death a near relative. " My younger brother, the thirteen strings are now ready on this horizontal pole. I shall use them. I shall address you. This is all that is necessary in your case."

So then he took one bunch off the pole and held it in his hand while he talked. While he talked one after another he took them down and gave one to Hayonhwatha after each part of his address.

The words that he spoke when he addressed Hayonhwatha were eight of the thirteen condolences.

When the eight ceremonial addresses had been made by Dekanawida the mind of Hayonhwatha was made clear. He was then satisfied and once more saw things rightly.

Dekanawida then said, " My younger brother, these thirteen strings of shell are now completed. In the future they shall be used in this way: They shall be held in the hand to remind the speaker of each part of his address, and as each part is finished a string shall be given to the bereaved chief (Royaneh) on the other side of the fire. Then shall the Royaneh hand them back one by one as he addresses a reply; it then can be said, ' I have now become even with you.' "

Dekanawida then said, " My junior brother, your mind being cleared and you being competent to judge, we now shall make our laws and when all are made we shall call the organization we have formed the Great Peace. It shall be the power to abolish war and robbery between brothers and bring peace and quietness.

"As emblems of our Royoneh titles we shall wear deer antlers and place them on the heads of Royaneh men."

Hayonhwatha then said, " What you have said is good, I do agree."

Dekanawida said, " My younger brother, since you have agreed I now propose that we compose our Peace song. We shall use it on our journey to pacify Adodarhoh. When he hears it his mind shall be made straight. His mind shall then be like that of other men. This will be true if the singer remembers and makes no error in his singing from the beginning to the end, as he walks before Adodarhoh."

Hayonhwatha said, "I do agree, I truly believe the truth of what you say."

Then Dekanawida said, "My younger brother, we shall now propose to the Mohawk council the plan we have made. We shall tell our plan for a confederation and the building of a house of peace. It will be necessary for us to know its opinion and have its consent to proceed."

The plan was talked about in the council and Dekanawida spoke of establishing a union of all the nations. He told them that all the chiefs must be virtuous men and be very patient. These should wear deer horns as emblems of their position, because as he told them their strength came from the meat of the deer. Then Hayonhwatha confirmed all that Dekanawida had said.

Then the speaker of the Mohawk council said, "You two, Dekanawida and Hayonhwatha, shall send messengers to the Oneida (People of the Stone) and they shall ask Odatshedeh if he will consider the plan."

When Odatshedeh had been asked he replied, "I will consider this plan and answer you tomorrow."

When the tomorrow of the next year had come, there came the answer of the Oneida council, "We will join the confederation."

So then the Mohawks (Kanyenga) sent two messengers to Onondaga asking that the nation consider the proposals of Dekanawida. It was a midsummer day when the message went forth and the Onondaga council answered, "Return tomorrow at high sun." So the two great men returned home and waited until the next midsummer. Then the midday came and the Onondaga council sent messengers who said, "We have decided that it would be a good plan to build the fire and set about it with you." Dekanawida and Hayonhwatha heard this answer.

So then at the same time Dekanawida and Hayonhwatha sent messengers to the Cayuga nation and the answer was sent back. The Cayugas said they would send word of their decision tomorrow, upon the midsummer day. The next year at midsummer the Cayugas sent their answer and they said, "We do agree with Dekanawida and Hayonhwatha."

Now the People of the Great Hill were divided and were not agreed because there had been trouble between their war chiefs, but messengers were sent to them but the Senecas could not agree to listen and requested the messengers to return the next year. So when the messengers returned the councils did listen and considered

the proposals. After a year had passed they sent messengers to say that they had agreed to enter into the confederacy.

Then Dekanawida said, "I now will report to the Mohawk council the result of my work of five years." Hayonhwatha then said, "I do agree to the report."

THE ESTABLISHMENT OF THE GREAT PEACE

Dekanawida requested some of the Mohawk chiefs to call a council, so messengers were sent out among the people and the council was convened.

Dekanawida said, "I, with my co-worker, have a desire to now report what we have done on five successive midsummer days, of five successive years. We have obtained the consent of five nations. These are the Mohawks, the Oneidas, the Onondagas, the Cayugas and the Senecas. Our desire is to form a compact for a union of our nations. Our next step is to seek out Adodarhoh. It is he who has always set at naught all plans for the establishment of the Great Peace. We must seek his fire and look for his smoke."

The chief speaker of the council then said, "We do agree and confirm all you have said and we wish to appoint two spies who shall volunteer to seek out the smoke of Adodarhoh."

Two men then eagerly volunteered and Dekanawida asked them if they were able to transform themselves into birds or animals, for such must be the ability of the messengers who approached Adodarhoh. The two men replied, "We are able to transform ourselves into herons and cranes."

"Then you will not do for you will pause at the first creek or swamp and look for frogs and fish."

Two men then said, "We have magic that will transform us into humming birds. They fly very swiftly."

"Then you will not do because you are always hungry and are looking for flowers."

Two other men then said, "We can become the Dare, the white crane."

"Then you will not do because you are very wild and easily frightened. You would be afraid when the clouds move. You would become hungry and fly to the ground looking about for ground nuts."

Then two men who were crows by magic volunteered but they were told that crows talked too loudly, boasted and were full of mischief.

So then in the end two men who were powerful by the magic of the deer and the bear stepped before the council and were chosen. The speaker for the council then reported to Dekanawida that the spies were ready to go. Then they went.

Now Dekanawida addressed the council and he said, "I am Dekanawida and with me is my younger brother. We two now lay before you the laws by which to frame the Ka-ya-neh-renh-ko-wa. The emblems of the chief rulers shall be the antlers of deer. The titles shall be vested in certain women and the names shall be held in their maternal families forever." All the laws were then recited and Hayonhwatha confirmed them.

Dekanawida then sang the song to be used when conferring titles. So in this way all the work and the plans were reported to the Mohawk council and Hayonhwatha confirmed it all. Therefore the council adopted the plan.

When the spies returned the speaker of the council said, "Ska-non-donh, our ears are erected." Then the spies spoke and they said, "At great danger to ourselves we have seen Adodarhoh. We have returned and tell you that the body of Adodarhoh has seven crooked parts, his hair is infested with snakes and he is a cannibal."

The council heard the message and decided to go to Onondaga at midsummer.

Then Dekanawida taught the people the Hymn of Peace and the other songs. He stood before the door of the longhouse and walked before it singing the new songs. Many came and learned them so that many were strong by the magic of them when it was time to carry the Great Peace to Onondaga.

When the time had come, Dekanawida summoned the chiefs and people together and chose one man to sing the songs before Adodarhoh. Soon then this singer led the company through the forest and he preceded all, singing the Peace songs as he walked. Many old villages and camping places were passed as they went and the names were lifted to give the clan name holders. Now the party passed through these places:

Old Clearing
Overgrown with bushes
A temporary place
Protruding rocks
Between two places
Parties opposite at the council fire
In the Valley

Drooping Wing
On the Hillside
Man Standing
I have daubed it
Lake Bridge
Between two side hills
Lake Outlet
At the forks
Long Hill
Broken Branches Lying
The Spring
White
Corn Stalks on both sides
Two Hillsides
The Old Beast

All these places were in the Mohawk country.

Now they entered the Oneida country and the great chief Odatshedeh with his chiefs met them. Then all of them marched onward to Onondaga, the singer of the Peace Hymn going on ahead.

The frontier of the Onondaga country was reached and the expedition halted to kindle a fire, as was customary. Then the chiefs of the Onondagas with their head men welcomed them and a great throng marched to the fireside of Adodarhoh, the singer of the Peace Hymn leading the multitude.

The lodge of Adodarhoh was reached and a new singer was appointed to sing the Peace Hymn. So he walked before the door of the house singing to cure the mind of Adodarhoh. He knew that if he made a single error or hesitated his power would be weakened and the crooked body of Adodarhoh remain misshapen. Then he hesitated and made an error. So another singer was appointed and he too made an error by hesitating.

Then Dekanawida himself sang and walked before the door of Adodarhoh's house. When he finished his song he walked toward Adodarhoh and held out his hand to rub it on his body and to know its inherent strength and life. Then Adodarhoh was made straight and his mind became healthy.

When Adodarhoh was made strong in rightful powers and his body had been healed, Dekanawida addressed the three nations. He said, " We have now overcome a great obstacle. It has long stood in the way of peace. The mind of Adodarhoh is now made

right and his crooked parts are made straight. Now indeed may we establish the Great Peace.

"Before we do firmly establish our union each nation must appoint a certain number of its wisest and purest men who shall be rulers, Rodiyaner. They shall be the advisers of the people and make the new rules that may be needful. These men shall be selected and confirmed by their female relations in whose lines the titles shall be hereditary. When these are named they shall be crowned, emblematically, with deer antlers."

So then the women of the Mohawks brought forward nine chiefs who should become Rodiyaner and one man, Ayenwaehs, as war chief.

So then the women of the Oneidas brought forward nine chiefs who should become Rodiyaner, and one man, Kahonwadironh, who should be war chief.

So then the Onondaga women brought forward fourteen chiefs who should become Rodiyaner, and one man, Ayendes, who should be war chief.

Each chief then delivered to Dekanawida a string of lake shell wampum a span in length as a pledge of truth.

Dekanawida then said: "Now, today in the presence of this great multitude I disrobe you and you are not now covered by your old names. I now give you names much greater." Then calling each chief to him he said: "I now place antlers on your head as an emblem of your power. Your old garments are torn off and better robes are given you. Now you are Royaner, each of you. You will receive many scratches and the thickness of your skins shall be seven spans. You must be patient and henceforth work in unity. Never consider your own interests but work to benefit the people and for the generations not yet born. You have pledged yourselves to govern yourselves by the laws of the Great Peace. All your authority shall come from it.

"I do now order that Skanawateh shall in one-half of his being be a Royaneh of the Great Peace, and in his other half a war chief, for the Rodiyaner must have an ear to hear and a hand to feel the coming of wars."

Then did Dekanawida repeat all the rules which he with Ayonhwatha had devised for the establishment of the Great Peace.

Then in the councils of all the Five Nations he repeated them and the Confederacy was established.

THE COUNCIL OF THE GREAT PEACE

THE GREAT BINDING LAW, GAYANASHAGOWA

1 I am Dekanawidah and with the Five Nations' Confederate Lords[1] I plant the Tree of the Great Peace. I plant it in your territory, Adodarhoh, and the Onondaga Nation, in the territory of you who are Firekeepers.

I name the tree the Tree of the Great Long Leaves. Under the shade of this Tree of the Great Peace we spread the soft white feathery down of the globe thistle as seats for you, Adodarhoh, and your cousin Lords.

We place you upon those seats, spread soft with the feathery down of the globe thistle, there beneath the shade of the spreading branches of the Tree of Peace. There shall you sit and watch the Council Fire of the Confederacy of the Five Nations, and all the affairs of the Five Nations shall be transacted at this place before you, Adodarhoh, and your cousin Lords, by the Confederate Lords of the Five Nations. (1–I, TLL).[2]

2 Roots have spread out from the Tree of the Great Peace, one to the north, one to the east, one to the south and one to the west. The name of these roots is The Great White Roots and their nature is Peace and Strength.

If any man or any nation outside the Five Nations shall obey the laws of the Great Peace and make known their disposition to the Lords of the Confederacy, they may trace the Roots to the Tree and if their minds are clean and they are obedient and promise to obey the wishes of the Confederate Council, they shall be welcomed to take shelter beneath the Tree of the Long Leaves.

We place at the top of the Tree of the Long Leaves an Eagle who is able to see afar. If he sees in the distance any evil approaching or any danger threatening he will at once warn the people of the Confederacy. (2–II, TLL).

3 To you Adodarhoh, the Onondaga cousin Lords, I and the other Confederate Lords have entrusted the caretaking and the watching of the Five Nations Council Fire.

When there is any business to be transacted and the Confederate Council is not in session, a messenger shall be dispatched either to

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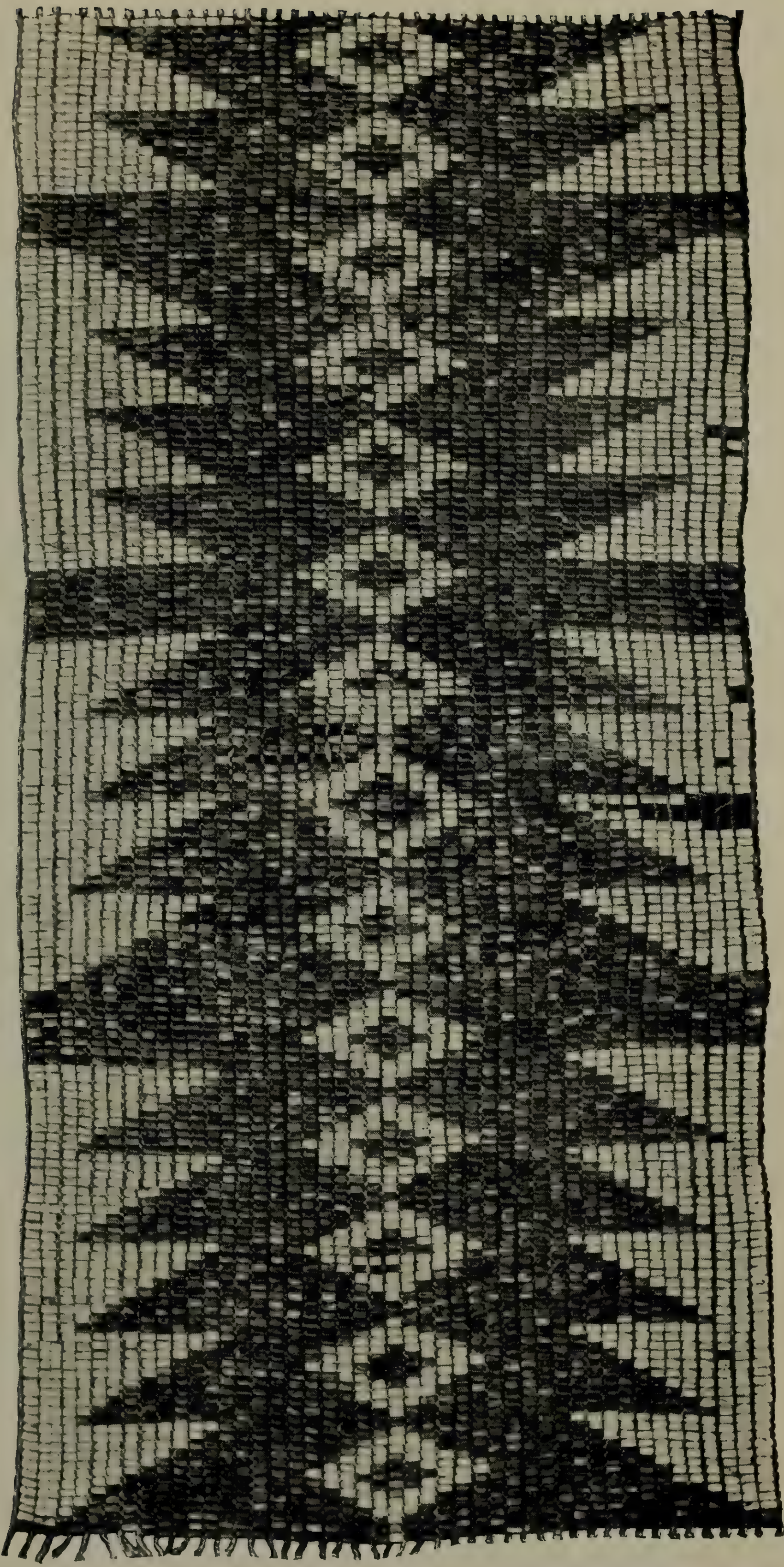
[1] Royaneh is always translated "lord."

[2] The abbreviations after each law refer to the sections in the original code and their numbers. TLL, means Tree of the Long Leaves; EUC, Emblematical Union Compact, and LPW, Skanawita's Laws of Peace and War. The first number in Roman numerals refers to the original number of the law, the second number, in Arabic numerals, to the section number in the division of the law named by the abbreviation following.

Plate 3



Belt of the covenant. Displayed by the speaker of the confederate council.

Adodarhoh, Hononwirehtonh or Skanawatih, Fire Keepers, or to their War Chiefs with a full statement of the case desired to be considered. Then shall Adodarho call his cousin (associate) Lords together and consider whether or not the case is of sufficient importance to demand the attention of the Confederate Council. If so, Adodarhoh shall dispatch messengers to summon all the Confederate Lords to assemble beneath the Tree of the Long Leaves.

When the Lords are assembled the Council Fire shall be kindled, but not with chestnut wood,[1] and Adodarhoh shall formally open the Council.

Then shall Adodarhoh and his cousin Lords, the Fire Keepers, announce the subject for discussion.

The Smoke of the Confederate Council Fire shall ever ascend and pierce the sky so that other nations who may be allies may see the Council Fire of the Great Peace.

Adodarho and his cousin Lords are entrusted with the Keeping of the Council Fire. (4–IV, TLL).

4 You, Adodarho, and your thirteen cousin Lords, shall faithfully keep the space about the Council Fire clean and you shall allow neither dust nor dirt to accumulate. I lay a Long Wing before you as a broom. As a weapon against a crawling creature I lay a staff with you so that you may thrust it away from the Council Fire. If you fail to cast it out then call the rest of the United Lords to your aid. (3–III, TLL).

5 The Council of the Mohawk shall be divided into three parties as follows: Tekarihoken, Ayonhwhathah and Shadekariwade are the first party; Sharenhowaneh, Deyoenhegwenh and Oghrenghrehgowah are the second party, and Dehennakrineh, Aghstawenserenthah and Shoskoharowaneh are the third party. The third party is to listen only to the discussion of the first and second parties and if an error is made or the proceeding is irregular they are to call attention to it, and when the case is right and properly decided by the two parties they shall confirm the decision of the two parties and refer the case to the Seneca Lords for their decision. When the Seneca Lords have decided in accord with the Mohawk Lords, the case or question shall be referred to the Cayuga and Oneida Lords on the opposite side of the house. (5–V, TLL).

6 I, Dekanawidah, appoint the Mohawk Lords the heads and the leaders of the Five Nations Confederacy. The Mohawk Lords are

[1] Because chestnut wood in burning throws out sparks, thereby creating a disturbance in the council.

the foundation of the Great Peace and it shall, therefore, be against the Great Binding Law to pass measures in the Confederate Council after the Mohawk Lords have protested against them. (6–VI, TLL).

No council of the Confederate Lords shall be legal unless all the Mohawk Lords are present. (13–XIII, TLL).

7 Whenever the Confederate Lords shall assemble for the purpose of holding a council, the Onondaga Lords shall open it by expressing their gratitude to their cousin Lords and greeting them, and they shall make an address and offer thanks to the earth where men dwell, to the streams of water, the pools, the springs and the lakes, to the maize and the fruits, to the medicinal herbs and trees, to the forest trees for their usefulness, to the animals that serve as food and give their pelts for clothing, to the great winds and the lesser winds, to the Thunderers, to the Sun, the mighty warrior, to the moon, to the messengers of the Creator who reveal his wishes and to the Great Creator[1] who dwells in the heavens above, who gives all the things useful to men, and who is the source and the ruler of health and life.

Then shall the Onondaga Lords declare the council open.

The council shall not sit after darkness has set in. (7–VII, TLL).

8 The Firekeepers shall formally open and close all councils of the Confederate Lords, they shall pass upon all matters deliberated upon by the two sides and render their decision.

Every Onondaga Lord (or his deputy) must be present at every Confederate Council and must agree with the majority without unwarrantable dissent, so that a unanimous decision may be rendered. (8–VIII, TLL).

If Adodarho or any of his cousin Lords are absent from a Confederate Council, any other Firekeeper may open and close the Council, but the Firekeepers present may not give any decisions, unless the matter is of small importance. (9–IX, TLL).

9 All the business of the Five Nations Confederate Council shall be conducted by the two combined bodies of Confederate Lords. First the question shall be passed upon by the Mohawk and Seneca Lords, then it shall be discussed and passed by the Oneida and Cayuga Lords. Their decisions shall then be referred to the Onondaga Lords, (Fire Keepers) for final judgment. (10–X, TLL).

The same process shall obtain when a question is brought before the council by an individual or a War Chief. (11–XI, TLL).

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[1] Hodiänok'doo^{n} Hĕdiohe' (Seneca).

10 In all cases the procedure must be as follows: when the Mohawk and Seneca Lords have unanimously agreed upon a question, they shall report their decision to the Cayuga and Oneida Lords who shall deliberate upon the question and report a unanimous decision to the Mohawk Lords. The Mohawk Lords will then report the standing of the case to the Firekeepers, who shall render a decision (17–XVII, TLL) as they see fit in case of a disagreement by the two bodies, or confirm the decisions of the two bodies if they are identical. The Fire Keepers shall then report their decision to the Mohawk Lords who shall announce it to the open council. (12–XII, TLL).

11 If through any misunderstanding or obstinacy on the part of the Fire Keepers, they render a decision at variance with that of the Two Sides, the Two Sides shall reconsider the matter and if their decisions are jointly the same as before they shall report to the Fire Keepers who are then compelled to confirm their joint decision. (18–XVIII, TLL).

12 When a case comes before the Onondaga Lords (Fire Keepers) for discussion and decision, Adodarho shall introduce the matter to his comrade Lords who shall then discuss it in their two bodies. Every Onondaga Lord except Hononwiretonh shall deliberate and he shall listen only. When a unanimous decision shall have been reached by the two bodies of Fire Keepers, Adodarho shall notify Hononwiretonh of the fact when he shall confirm it. He shall refuse to confirm a decision if it is not unanimously agreed upon by both sides of the Fire Keepers. (19–XIX, TLL).

13 No Lord shall ask a question of the body of Confederate Lords when they are discussing a case, question or proposition. He may only deliberate in a low tone with the separate body of which he is a member. (21–XXI, TLL).

14 When the Council of the Five Nation Lords shall convene they shall appoint a speaker for the day. He shall be a Lord of either the Mohawk, Onondaga or Seneca Nation.

The next day the Council shall appoint another speaker, but the first speaker may be reappointed if there is no objection, but a speaker's term shall not be regarded more than for the day. (35–XXXV, TLL).

15 No individual or foreign nation interested in a case, question or proposition shall have any voice in the Confederate Council except to answer a question put to him or them by the speaker for the Lords. (41–XLI, TLL).

16 If the conditions which shall arise at any future time call for an addition to or change of this law, the case shall be carefully considered and if a new beam seems necessary or beneficial, the proposed change shall be voted upon and if adopted it shall be called, "Added to the Rafters." (48–XLVII, TLL).

Rights, duties and qualifications of Lords

17 A bunch of a certain number of shell (wampum) strings each two spans in length shall be given to each of the female families in which the Lordship titles are vested. The right of bestowing the title shall be hereditary in the family of females legally possessing the bunch of shell strings and the strings shall be the token that the females of the family have the proprietary right to the Lordship title for all time to come, subject to certain restrictions hereinafter mentioned. (59–LIX, TLL).

18 If any Confederate Lord neglects or refuses to attend the Confederate Council, the other Lords of the Nation of which he is a member shall require their War Chief to request the female sponsors of the Lord so guilty of defection to demand his attendance of the Council. If he refuses, the women holding the title shall immediately select another candidate for the title.

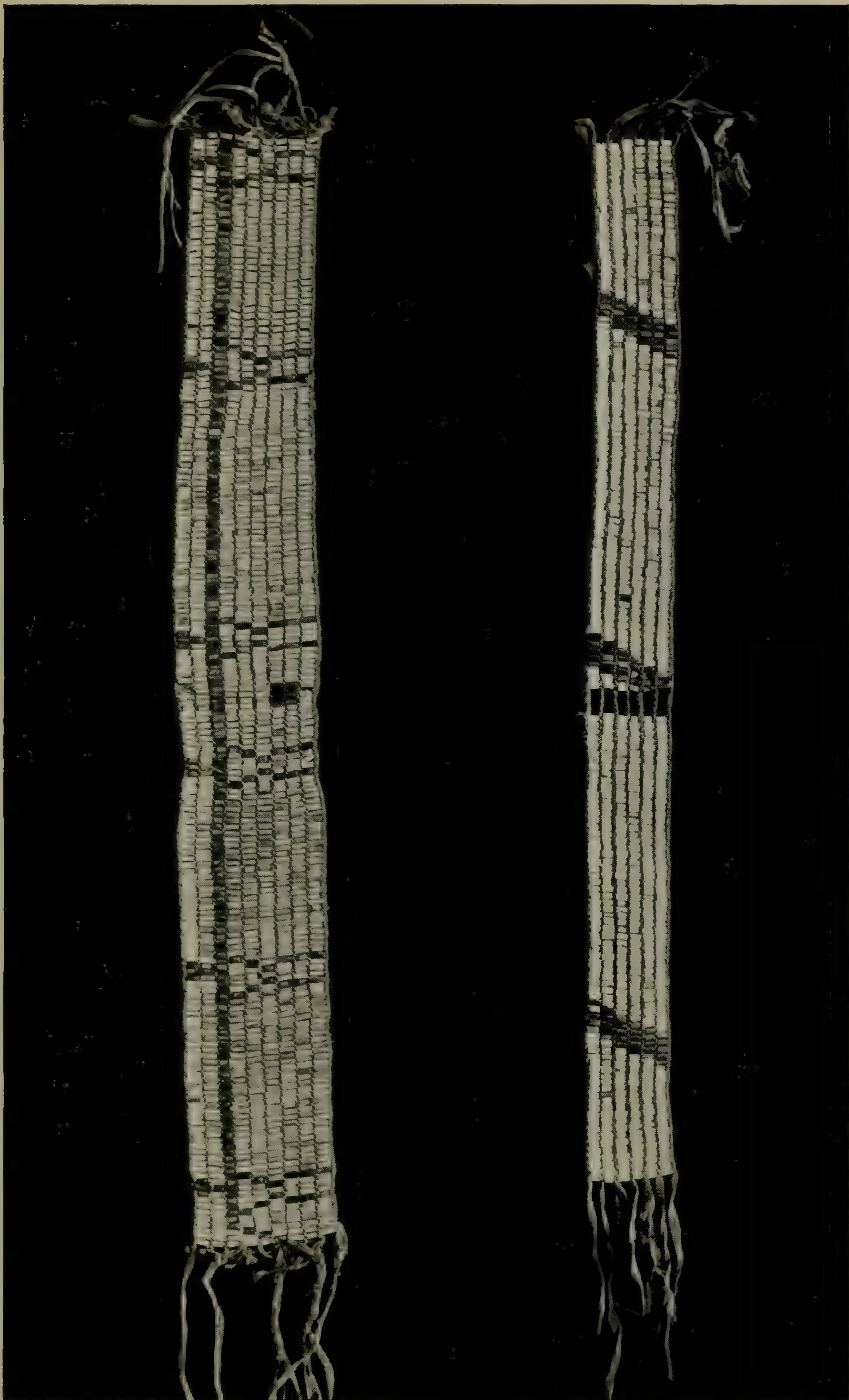
No Lord shall be asked more than once to attend the Confederate Council. (30–XXX, TLL).

19 If at any time it shall be manifest that a Confederate Lord has not in mind the welfare of the people or disobeys the rules of this Great Law, the men or the women of the Confederacy, or both jointly,[1] shall come to the Council and upbraid the erring Lord through his War Chief. If the complaint of the people through the War Chief is not heeded the first time it shall be uttered again and then if no attention is given a third complaint and warning shall be given. If the Lord is still contumacious the matter shall go to the council of War Chiefs. (66–LXVI, TLL). The War Chiefs shall then divest the erring Lord of his title by order of the women in whom the titleship is vested. When the Lord is deposed the women shall notify the Confederate Lords through their War Chief, and the Confederate Lords shall sanction the act. The women will then select another of their sons as a candidate and the Lords shall elect him. Then shall the chosen one be installed by the Installation Ceremony. (123–XLI, EUC), (Cf. 42–XLII).

[1] See sections 94 and 95 for right of popular councils.

Plate 4

1 2



1 Nomination belt used to confirm the nomination of the civil chiefs
2 Welcome belt used in welcoming delegates

When a Lord is to be deposed, his War Chief shall address him as follows:

"So you, ——————, disregard and set at naught the warnings of your women relatives. So you fling the warnings over your shoulder to cast them behind you.

"Behold the brightness of the Sun and in the brightness of the Sun's light I depose you of your title and remove the sacred emblem of your Lordship title. I remove from your brow the deer's antlers, which was the emblem of your position and token of your nobility. I now depose you and return the antlers to the women whose heritage they are."

The War Chief shall now address the women of the deposed Lord and say:

"Mothers, as I have now deposed your Lord, I now return to you the emblem and the title of Lordship, therefore repossess them."

Again addressing himself to the deposed Lord he shall say:

"As I have now deposed and discharged you so you are now no longer Lord. You shall now go your way alone, the rest of the people of the Confederacy will not go with you, for we know not the kind of mind that possesses you. As the Creator has nothing to do with wrong so he will not come to rescue you from the precipice of destruction in which you have cast yourself. You shall never be restored to the position which you once occupied."

Then shall the War Chief address himself to the Lords of the Nation to which the deposed Lord belongs and say:

"Know you, my Lords, that I have taken the deer's antlers from the brow of ——————, the emblem of his position and token of his greatness."

The Lords of the Confederacy shall then have no other alternative than to sanction the discharge of the offending Lord. (42–XLII, TLL).

20 If a Lord of the Confederacy of the Five Nations should commit murder the other Lords of the Nation shall assemble at the place where the corpse lies and prepare to depose the criminal Lord. If it is impossible to meet at the scene of the crime the Lords shall discuss the matter at the next Council of their nation and request their War Chief to depose the Lord guilty of crime, to "bury" his women relatives and to transfer the Lordship title to a sister family.

The War Chief shall address the Lord guilty of murder and say:

"So you, ———— (giving his name) did kill ———— (naming the slain man), with your own hands! You have committed a grave sin in the eyes of the Creator. Behold the bright light of the Sun, and in the brightness of the Sun's light I depose you of your title and remove the horns, the sacred emblems of your Lordship title. I remove from your brow the deer's antlers, which was the emblem of your position and token of your nobility. I now depose you and expel you and you shall depart at once from the territory of the Five Nations Confederacy and nevermore return again. We, the Five Nations Confederacy, moreover, bury your women relatives because the ancient Lordship title was never intended to have any union with bloodshed. Henceforth it shall not be their heritage. By the evil deed that you have done they have forfeited it forever."

The War Chief shall then hand the title to a sister family and he shall address it and say:

"Our mothers, ————, listen attentively while I address you on a solemn and important subject. I hereby transfer to you an ancient Lordship title for a great calamity has befallen it in the hands of the family of a former Lord. We trust that you, our mothers, will always guard it, and that you will warn your Lord always to be dutiful and to advise his people to ever live in love, peace and harmony that a great calamity may never happen again." (47–XLVII, TLL).

21 Certain physical defects in a Confederate Lord make him ineligible to sit in the Confederate Council. Such defects are infancy, idiocy, blindness, deafness, dumbness and impotency. When a Confederate Lord is restricted by any of these conditions, a deputy shall be appointed by his sponsors to act for him, but in case of extreme necessity the restricted Lord may exercise his rights. (29–XXIX, TLL).

22 If a Confederate Lord desires to resign his title he shall notify the Lords of the Nation of which he is a member of his intention. If his coactive Lords refuse to accept his resignation he may not resign his title.

A Lord in proposing to resign may recommend any proper candidate which recommendation shall be received by the Lords, but unless confirmed and nominated by the women who hold the title the candidate so named shall not be considered. (31–XXXI, TLL).

23 Any Lord of the Five Nations Confederacy may construct shell strings (or wampum belts) of any size or length as pledges or records of matters of national or international importance.

When it is necessary to dispatch a shell string by a War Chief or other messenger as the token of a summons, the messenger shall recite the contents of the string to the party to whom it is sent. That party shall repeat the message and return the shell string and if there has been a summons he shall make ready for the journey.

Any of the people of the Five Nations may use shells (or wampum) as the record of a pledge, contract or an agreement entered into and the same shall be binding as soon as shell strings shall have been exchanged by both parties. (32–XXXII, TLL).

24 The Lords of the Confederacy of the Five Nations shall be mentors of the people for all time. The thickness of their skin shall be seven spans — which is to say that they shall be proof against anger, offensive actions and criticism. Their hearts shall be full of peace and good will and their minds filled with a yearning for the welfare of the people of the Confederacy. With endless patience they shall carry out their duty and their firmness shall be tempered with a tenderness for their people. Neither anger nor fury shall find lodgement in their minds and all their words and actions shall be marked by calm deliberation. (33–XXXIII, TLL).

25 If a Lord of the Confederacy should seek to establish any authority independent of the jurisdiction of the Confederacy of the Great Peace, which is the Five Nations, he shall be warned three times in open council, first by the women relatives, second by the men relatives and finally by the Lords of the Confederacy of the Nation to which he belongs. If the offending Lord is still obdurate he shall be dismissed by the War Chief of his nation for refusing to conform to the laws of the Great Peace. His nation shall then install the candidate nominated by the female name holders of his family. (34–XXXIV, TLL).

26 It shall be the duty of all of the Five Nations Confederate Lords, from time to time as occasion demands, to act as mentors and spiritual guides of their people and remind them of their Creator's will and words. They shall say:

" Hearken, that peace may continue unto future days!

"Always listen to the words of the Great Creator, for he has spoken.

" United People, let not evil find lodging in your minds

" For the Great Creator has spoken and the cause of Peace shall not become old.

"The cause of peace shall not die if you remember the Great Creator."

Every Confederate Lord shall speak words such as these to promote peace. (37–XXXVII, TLL).

27 All Lords of the Five Nations Confederacy must be honest in all things. They must not idle or gossip, but be men possessing those honorable qualities that make true royaneh. It shall be a serious wrong for anyone to lead a Lord into trivial affairs, for the people must ever hold their Lords high in estimation out of respect to their honorable positions. (45–XLV, TLL).

28 When a candidate Lord is to be installed he shall furnish four strings of shells (or wampum) one span in length bound together at one end. Such will constitute the evidence of his pledge to the Confederate Lords that he will live according to the constitution of the Great Peace and exercise justice in all affairs.

When the pledge is furnished the Speaker of the Council must hold the shell strings in his hand and address the opposite side of the Council Fire and he shall commence his address saying: "Now behold him. He has now become a Confederate Lord. See how splendid he looks." An address may then follow. At the end of it he shall send the bunch of shell strings to the opposite side and they shall be received as evidence of the pledge. Then shall the opposite side say:

"We now do crown you with the sacred emblem of the deer's antlers, the emblem of your Lordship. You shall now become a mentor of the people of the Five Nations. The thickness of your skin shall be seven spans — which is to say that you shall be proof against anger, offensive actions and criticism. Your heart shall be filled with peace and good will and your mind filled with a yearning for the welfare of the people of the Confederacy. With endless patience you shall carry out your duty and your firmness shall be tempered with tenderness for your people. Neither anger nor fury shall find lodgement in your mind and all your words and actions shall be marked with calm deliberation. In all of your deliberations in the Confederate Council, in your efforts at law making, in all your official acts, self interest shall be cast into oblivion. Cast not over your shoulder behind you the warnings of the nephews and nieces should they chide you for any error or wrong you may do, but return to the way of the Great Law which is just and right. Look and listen for the welfare of the whole people and have always in view not only the present but also the coming generations, even

those whose faces are yet beneath the surface of the ground — the unborn of the future Nation." (51–LI, TLL).

29 When a Lordship title is to be conferred, the candidate Lord shall furnish the cooked venison, the corn bread and the corn soup, together with other necessary things and the labor for the Conferring of Titles Festival. (50–L, TLL).

30 The Lords of the Confederacy may confer the Lordship title upon a candidate whenever the Great Law is recited, if there be a candidate, for the Great Law speaks all the rules. (XLIV–44, TLL).

31 If a lord of the Confederacy should become seriously ill and be thought near death, the women who are heirs of his title shall go to his house and lift his crown of deer antlers, the emblem of his Lordship, and place them at one side. If the Creator spares him and he rises from his bed of sickness he may rise with the antlers on his brow.

The following words shall be used to temporarily remove the antlers:

"Now our comrade Lord (or our relative Lord) the time has come when we must approach you in your illness. We remove for a time the deer's antlers from your brow, we remove the emblem of your Lordship title. The Great Law has decreed that no Lord should end his life with the antlers on his brow. We therefore lay them aside in the room. If the Creator spares you and you recover from your illness you shall rise from your bed with the antlers on your brow as before and you shall resume your duties as Lord of the Confederacy and you may labor again for the Confederate people." (XXVII–27, TLL).

32 If a Lord of the Confederacy should die while the Council of the Five Nations is in session the Council shall adjourn for ten days. No Confederate Council shall sit within ten days of the death of a Lord of the Confederacy.

If the Three Brothers (the Mohawk, the Onondaga and the Seneca) should lose one of their Lords by death, the Younger Brothers (the Oneida and the Cayuga) shall come to the surviving Lords of the Three Brothers on the tenth day and console them. If the Younger Brothers lose one of their Lords then the Three Brothers shall come to them and console them. And the consolation shall be the reading of the contents of the thirteen shell (wampum) strings of Ayonhwhathah. At the termination of this rite a successor shall be appointed, to be appointed by the women

heirs of the Lordship title. If the women are not yet ready to place their nominee before the Lords the Speaker shall say, " Come let us go out." All shall then leave the Council or the place of gathering. The installation shall then wait until such a time as the women are ready. The Speaker shall lead the way from the house by saying, " Let us depart to the edge of the woods and lie in waiting on our bellies."

When the women title holders shall have chosen one of their sons the Confederate Lords will assemble in two places, the Younger Brothers in one place and the Three Older Brothers in another. The Lords who are to console the mourning Lords shall choose one of their number to sing the Pacification Hymn as they journey to the sorrowing Lords. The singer shall lead the way and the Lords and the people shall follow. When they reach the sorrowing Lords they shall hail the candidate Lord and perform the rite of Conferring the Lordship Title. (22–XXII, TLL).

33 When a Confederate Lord dies, the surviving relatives shall immediately dispatch a messenger, a member of another clan, to the Lords in another locality. When the runner comes within hailing distance of the locality he shall utter a sad wail, thus: " Kwa-ah, Kwa-ah, Kwa-ah ! " The sound shall be repeated three times and then again and again at intervals as many times as the distance may require. When the runner arrives at the settlement the people shall assemble and one must ask him the nature of his sad message. He shall then say, " Let us consider." Then he shall tell them of the death of the Lord. He shall deliver to them a string of shells (wampum) and say " Here is the testimony, you have heard the message." He may then return home.

It now becomes the duty of the Lords of the locality to send runners to other localities and each locality shall send other messengers until all Lords are notified. Runners shall travel day and night. (23–XXIII, TLL).

34 If a Lord dies and there is no candidate qualified for the office in the family of the women title holders, the Lords of the Nation shall give the title into the hands of a sister family in the clan until such a time as the original family produces a candidate, when the title shall be restored to the rightful owners.

No Lordship title may be carried into the grave. The Lords of the Confederacy may dispossess a dead Lord of his title even at the grave. (24–XXIV, TLL).

Election of Pine Tree chiefs

35 Should any man of the Nation assist with special ability or show great interest in the affairs of the Nation, if he proves himself wise, honest and worthy of confidence, the Confederate Lords may elect him to a seat with them and he may sit in the Confederate Council. He shall be proclaimed a *Pine Tree sprung up for the Nation* and be installed as such at the next assembly for the installation of Lords. Should he ever do anything contrary to the rules of the Great Peace, he may not be deposed from office — no one shall cut him down[1] — but thereafter everyone shall be deaf to his voice and his advice. Should he resign his seat and title no one shall prevent him. A Pine Tree chief has no authority to name a successor nor is his title hereditary. (LXVIII–68, TLL).

Names, duties and rights of war chiefs

36 The title names of the Chief Confederate Lords' War Chiefs shall be:
Ayonwaehs, War Chief under Lord Takarihoken (Mohawk)
Kahonwahdironh, War Chief under Lord Odatshedeh (Oneida)
Ayendes, War Chief under Lord Adodarhoh (Onondaga)
Wenenhs, War Chief under Lord Dekaenyonh (Cayuga)
Shoneradowaneh, War Chief under Lord Skanyadariyo (Seneca)

The women heirs of each head Lord's title shall be the heirs of the War Chief's title of their respective Lord. (52–LII, TLL).

The War Chiefs shall be selected from the eligible sons of the female families holding the head Lordship titles. (53–LIII, TLL).

37 There shall be one War Chief for each Nation and their duties shall be to carry messages for their Lords and to take up the arms of war in case of emergency. They shall not participate in the proceedings of the Confederate Council but shall watch its progress and in case of an erroneous action by a Lord they shall receive the complaints of the people and convey the warnings of the women to him. The people who wish to convey messages to the Lords in the Confederate Council shall do so through the War Chief of their Nation. It shall ever be his duty to lay the cases, questions and propositions of the people before the Confederate Council. (54–LIV, TLL).

38 When a War Chief dies another shall be installed by the same rite as that by which a Lord is installed. (56–LVI, TLL).

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[1] Because, "his top branches pierce the sky and if his roots are cut he will not fall but hang upright before the people."

39 If a War Chief acts contrary to instructions or against the provisions of the Laws of the Great Peace, doing so in the capacity of his office, he shall be deposed by his women relatives and by his men relatives. Either the women or the men alone or jointly may act in such case. The women title holders shall then choose another candidate. (55–LV, TLL).

40 When the Lords of the Confederacy take occasion to dispatch a messenger in behalf of the Confederate Council, they shall wrap up any matter they may send and instruct the messenger to remember his errand, to turn not aside but to proceed faithfully to his destination and deliver his message according to every instruction. (57–XLVII, TLL).

41 If a message borne by a runner is the warning of an invasion he shall whoop, "Kwa-ah, Kwa-ah," twice and repeat at short intervals; then again at a longer interval.

If a human being is found dead, the finder shall not touch the body but return home immediately shouting at short intervals, "Koo-weh!" (23–XXIII, TLL).

Clans and consanguinity

42 Among the Five Nations and their posterity there shall be the following original clans: Great Name Bearer, Ancient Name Bearer, Great Bear, Ancient Bear, Turtle, Painted Turtle, Standing Rock, Large Plover, Little Plover, Deer, Pigeon Hawk, Eel, Ball, Opposite-Side-of-the-Hand, and Wild Potatoes. These clans distributed through their respective Nations, shall be the sole owners and holders of the soil of the country and in them is it vested as a birthright. (94–XI, EUC).

43 People of the Five Nations members of a certain clan shall recognize every other member of that clan, irrespective of the Nation, as relatives. Men and women, therefore, members of the same clan are forbidden to marry. (98–XV, EUC).

44 The lineal descent of the people of the Five Nations shall run in the female line. Women shall be considered the progenitors of the Nation. They shall own the land and the soil. Men and women shall follow the status of the mother. (60–LX, TLL).

45 The women heirs of the Confederate Lordship titles shall be called Royaneh (Noble) for all time to come. (61–LXI, TLL).

46 The women of the Forty Eight (now fifty) Royaneh families shall be the heirs of the Authorized Names for all time to come.

When an infant of the Five Nations is given an Authorized Name at the Midwinter Festival or at the Ripe Corn Festival, one in the cousinhood of which the infant is a member shall be appointed a speaker. He shall then announce to the opposite cousinhood the names of the father and the mother of the child together with the clan of the mother. Then the speaker shall announce the child's name twice. The uncle of the child shall then take the child in his arms and walking up and down the room shall sing: "My head is firm, I am of the Confederacy." As he sings the opposite cousinhood shall respond by chanting, "Hyenh, Hyenh, Hyenh, Hyenh," until the song is ended. (95–XII, EUC).

47 If the female heirs of a Confederate Lord's title become extinct, the title right shall be given by the Lords of the Confederacy to the sister family whom they shall elect and that family shall hold the name and transmit it to their (female) heirs, but they shall not appoint any of their sons as a candidate for a title until all the eligible men of the former family shall have died or otherwise have become ineligible. (25–XXV, TLL).

48 If all the heirs of a Lordship title become extinct, and all the families in the clan, then the title shall be given by the Lords of the Confederacy to the family in a sister clan whom they shall elect. (26–XXVI, TLL).

49 If any of the Royaneh women, heirs of a titleship, shall wilfully withhold a Lordship or other title and refuse to bestow it, or if such heirs abandon, forsake or despise their heritage, then shall such women be deemed buried and their family extinct. The titleship shall then revert to a sister family or clan upon application and complaint. The Lords of the Confederacy shall elect the family or clan which shall in future hold the title. (28–XXVIII, TLL).

50 The Royaneh women of the Confederacy heirs of the Lordship titles shall elect two women of their family as cooks for the Lord when the people shall assemble at his house for business or other purposes.

It is not good nor honorable for a Confederate Lord to allow his people whom he has called to go hungry. (62–LXII, TLL).

51 When a Lord holds a conference in his home, his wife, if she wishes, may prepare the food for the Union Lords who assemble with him. This is an honorable right which she may exercise and an expression of her esteem. (38–XXXVIII, TLL).

52 The Royaneh women, heirs of the Lordship titles, shall, should it be necessary, correct and admonish the holders of their titles. Those only who attend the Council may do this and those

who do not shall not object to what has been said nor strive to undo the action. (63–LXIII, TLL).

53 When the Royaneh women, holders of a Lordship title, select one of their sons as a candidate, they shall select one who is trustworthy, of good character, of honest disposition, one who manages his own affairs, supports his own family, if any, and who has proven a faithful man to his Nation. (64–LXIV, TLL).

54 When a Lordship title becomes vacant through death or other cause, the Royaneh women of the clan in which the title is hereditary shall hold a council and shall choose one from among their sons to fill the office made vacant. Such a candidate shall not be the father of any Confederate Lord. If the choice is unanimous the name is referred to the men relatives of the clan. If they should disapprove it shall be their duty to select a candidate from among their own number. If then the men and women are unable to decide which of the two candidates shall be named, then the matter shall be referred to the Confederate Lords in the Clan. They shall decide which candidate shall be named. If the men and the women agree to a candidate his name shall be referred to the sister clans for confirmation. If the sister clans confirm the choice, they shall refer their action to their Confederate Lords who shall ratify the choice and present it to their cousin Lords, and if the cousin Lords confirm the name then the candidate shall be installed by the proper ceremony for the conferring of Lordship titles. (65–LXV, TLL).

Official symbolism

55 A large bunch of shell strings, in the making of which the Five Nations Confederate Lords have equally contributed, shall symbolize the completeness of the union and certify the pledge of the nations represented by the Confederate Lords of the Mohawk, the Oneida, the Onondaga, the Cayuga and the Seneca, that all are united and formed into one body or union called the Union of the Great Law, which they have established.

A bunch of shell strings is to be the symbol of the council fire of the Five Nations Confederacy. And the Lord whom the Council of Fire Keepers shall appoint to speak for them in opening the council shall hold the strands of shells in his hands when speaking. When he finishes speaking he shall deposit the strings on an elevated place (or pole) so that all the assembled Lords and the people may see it and know that the council is open and in progress.

When the council adjourns the Lord who has been appointed by

his comrade Lords to close it shall take the strands of shells in his hands and address the assembled Lords. Thus will the council adjourn until such a time and place as appointed by the council. Then shall the shell strings be placed in a place for safekeeping.

Every five years the Five Nations Confederate Lords and the people shall assemble together and shall ask one another if their minds are still in the same spirit of unity for the Great Binding Law and if any of the Five Nations shall not pledge continuance and steadfastness to the pledge of unity then the Great Binding Law shall dissolve. (14–XIV, TLL).

56 Five strings of shell tied together as one shall represent the Five Nations. Each string shall represent one territory and the whole a completely united territory known as the Five Nations Confederate territory. (108–XXV, EUC).

57 Five arrows shall be bound together very strong and each arrow shall represent one nation. As the five arrows are strongly bound this shall symbolize the complete union of the nations. Thus are the Five Nations united completely and enfolded together, united into one head, one body and one mind. Therefore they shall labor, legislate and council together for the interest of future generations.

The Lords of the Confederacy shall eat together from one bowl the feast of cooked beaver's tail. While they are eating they are to use no sharp utensils for if they should they might accidentally cut one another and bloodshed would follow. All measures must be taken to prevent the spilling of blood in any way. (15–XV, TLL).

58 There are now the Five Nations Confederate Lords standing with joined hands in a circle. This signifies and provides that should any one of the Confederate Lords leave the council and this Confederacy his crown of deer's horns, the emblem of his Lordship title, together with his birthright, shall lodge on the arms of the Union Lords whose hands are so joined. He forfeits his title and the crown falls from his brow but it shall remain in the Confederacy.

A further meaning of this is that if any time any one of the Confederate Lords choose to submit to the law of a foreign people he is no longer in but out of the Confederacy, and persons of this class shall be called "They have alienated themselves." Likewise such persons who submit to laws of foreign nations shall forfeit all birthrights and claims on the Five Nations Confederacy and territory.

You, the Five Nations Confederate Lords, be firm so that if a tree falls upon your joined arms it shall not separate you or weaken your hold. So shall the strength of the union be preserved. (16–XIV, TLL).

59 A bunch of wampum shells on strings, three spans of the hand in length, the upper half of the bunch being white and the lower half black, and formed from equal contributions of the men of the Five Nations, shall be a token that the men have combined themselves into one head, one body and one thought, and it shall also symbolize their ratification of the peace pact of the Confederacy, whereby the Lords of the Five Nations have established the Great Peace.

The white portion of the shell strings represent the women and the black portion the men. The black portion, furthermore, is a token of power and authority vested in the men of the Five Nations.

This string of wampum vests the people with the right to correct their erring Lords. In case a part or all the Lords pursue a course not vouched for by the people and heed not the third warning of their women relatives, then the matter shall be taken to the General Council of the women of the Five Nations. If the Lords notified and warned three times fail to heed, then the case falls into the hands of the men of the Five Nations. The War Chiefs shall then, by right of such power and authority, enter the open council to warn the Lord or Lords to return from their wrong course. If the Lords heed the warning they shall say, "we will reply tomorrow." If then an answer is returned in favor of justice and in accord with this Great Law, then the Lords shall individually pledge themselves again by again furnishing the necessary shells for the pledge. Then shall the War Chief or Chiefs exhort the Lords urging them to be just and true.

Should it happen that the Lords refuse to heed the third warning, then two courses are open: either the men may decide in their council to depose the Lord or Lords or to club them to death with war clubs. Should they in their council decide to take the first course the War Chief shall address the Lord or Lords, saying: "Since you the Lords of the Five Nations have refused to return to the procedure of the Constitution, we now declare your seats vacant, we take off your horns, the token of your Lordship, and others shall be chosen and installed in your seats, therefore vacate your seats."

Should the men in their council adopt the second course, the War Chief shall order his men to enter the council, to take positions beside the Lords, sitting between them wherever possible. When this is accomplished the War Chief holding in his outstretched hand a bunch of black wampum strings shall say to the erring Lords: "So now, Lords of the Five United Nations, harken to these last words from your men. You have not heeded the warnings of the women relatives, you have not heeded the warnings of the General Council of women and you have not heeded the warnings of the men of the nations, all urging you to return to the right course of action. Since you are determined to resist and to withhold justice from your people there is only one course for us to adopt." At this point the War Chief shall let drop the bunch of black wampum and the men shall spring to their feet and club the erring Lords to death. Any erring Lord may submit before the War Chief lets fall the black wampum. Then his execution is withheld.

The black wampum here used symbolizes that the power to execute is buried but that it may be raised up again by the men. It is buried but when occasion arises they may pull it up and derive their power and authority to act as here described. (SPW 81 XII).

60 A broad dark belt of wampum of thirty-eight rows, having a white heart in the center, on either side of which are two white squares all connected with the heart by white rows of beads shall be the emblem of the unity of the Five Nations.[1]

The first of the squares on the left represents the Mohawk nation and its territory; the second square on the left and the one near the heart, represents the Oneida nation and its territory; the white heart in the middle represents the Onondaga nation and its territory, and it also means that the heart of the Five Nations is single in its loyalty to the Great Peace, that the Great Peace is lodged in the heart (meaning with Onondaga Confederate Lords), and that the Council Fire is to burn there for the Five Nations, and further, it means that the authority is given to advance the cause of peace whereby hostile nations out of the Confederacy shall cease warfare; the white square to the right of the heart represents the Cayuga nation and its territory and the fourth and last white square represents the Seneca nation and its territory.

White shall here symbolize that no evil or jealous thoughts shall creep into the minds of the Lords while in council under the Great

[1] This is the "Hiawatha Belt" purchased by John Boyd Thatcher of Albany and now in the Congressional Library.

Peace. White, the emblem of peace, love, charity and equity surrounds and guards the Five Nations. (84–EUC, 1).

61 Should a great calamity threaten the generations rising and living of the Five United Nations, then he who is able to climb to the top of the Tree of the Great Long Leaves may do so. When, then, he reaches the top of the Tree he shall look about in all directions, and, should he see that evil things indeed are approaching, then he shall call to the people of the Five United Nations assembled beneath the Tree of the Great Long Leaves and say: "A calamity threatens your happiness."

Then shall the Lords convene in council and discuss the impending evil.

When all the truths relating to the trouble shall be fully known and found to be truths, then shall the people seek out a Tree of Ka-hon-ka-ah-go-nah,[1] and when they shall find it they shall assemble their heads together and lodge for a time between its roots. Then, their labors being finished, they may hope for happiness for many days after. (II-85, EUC).

62 When the Confederate Council of the Five Nations declares for a reading of the belts of shell calling to mind these laws, they shall provide for the reader a specially made mat woven of the fibers of wild hemp. The mat shall not be used again, for such formality is called the honoring of the importance of the law. (XXXVI–36, TLL).

63 Should two sons of opposite sides of the council fire agree in a desire to hear the reciting of the laws of the Great Peace and so refresh their memories in the way ordained by the founder of the Confederacy, they shall notify Adodarho. He then shall consult with five of his coactive Lords and they in turn shall consult their eight brethren. Then should they decide to accede to the request of the two sons from opposite sides of the Council Fire, Adodarhoh shall send messengers to notify the Chief Lords of each of the Five Nations. Then they shall despatch their War Chiefs to notify their brother and cousin Lords of the meeting and its time and place.

When all have come and have assembled, Adodarhoh, in conjunction with his cousin Lords, shall appoint one Lord who shall repeat the laws of the Great Peace. Then shall they announce who they have chosen to repeat the laws of the Great Peace to the two sons. Then shall the chosen one repeat the laws of the Great Peace. (XLIII–43, TLL).

[1] A great swamp Elm.

64 At the ceremony of the installation of Lords if there is only one expert speaker and singer of the law and the Pacification Hymn to stand at the council fire, then when this speaker and singer has finished addressing one side of the fire he shall go to the opposite side and reply to his own speech and song. He shall thus act for both sides of the fire until the entire ceremony has been completed. Such a speaker and singer shall be termed the "Two Faced" because he speaks and sings for both sides of the fire. (XLIX–49, TLL).

65 I, Dekanawida, and the Union Lords, now uproot the tallest pine tree and into the cavity thereby made we cast all weapons of war. Into the depths of the earth, down into the deep underearth currents of water flowing to unknown regions we cast all the weapons of strife. We bury them from sight and we plant again the tree. Thus shall the Great Peace be established and hostilities shall no longer be known between the Five Nations but peace to the United People.

Laws of adoption

66 The father of a child of great comliness, learning, ability or specially loved because of some circumstance may, at the will of the child's clan, select a name from his own (the father's) clan and bestow it by ceremony, such as is provided. This naming shall be only temporary and shall be called, "A name hung about the neck." (XII–96, EUC).

67 Should any person, a member of the Five Nations' Confederacy, specially esteem a man or a woman of another clan or of a foreign nation, he may choose a name and bestow it upon that person so esteemed. The naming shall be in accord with the ceremony of bestowing names. Such a name is only a temporary one and shall be called "A name hung about the neck." A short string of shells shall be delivered with the name as a record and a pledge. (XIV–97, EUC).

68 Should any member of the Five Nations, a family or person belonging to a foreign nation submit a proposal for adoption into a clan of one of the Five Nations, he or they shall furnish a string of shells, a span in length, as a pledge to the clan into which he or they wish to be adopted. The Lords of the nation shall then consider the proposal and submit a decision. (XXI–104, EUC).

69 Any member of the Five Nations who through esteem or other feeling wishes to adopt an individual, a family or number of families may offer adoption to him or them and if accepted the

matter shall be brought to the attention of the Lords for confirmation and the Lords must confirm the adoption. (XXII–105, EUC).

70 When the adoption of anyone shall have been confirmed by the Lords of the Nation, the Lords shall address the people of their nation and say: " Now you of our nation, be informed that such a person, such a family or such families have ceased forever to bear their birth nation's name and have buried it in the depths of the earth. Henceforth let no one of our nation ever mention the original name or nation of their birth. To do so will be to hasten the end of our peace. (XXIII–106, EUC).

Laws of emigration

71 When any person or family belonging to the Five Nations desires to abandon their birth nation and the territory of the Five Nations, they shall inform the Lords of their nation and the Confederate Council of the Five Nations shall take cognizance of it. (XXXIX–39, TLL).

72 When any person or any of the people of the Five Nations emigrate and reside in a region distant from the territory of the Five Nations Confederacy, the Lords of the Five Nations at will may send a messenger carrying a broad belt of black shells and when the messenger arrives he shall call the people together or address them personally displaying the belt of shells and they shall know that this is an order for them to return to their original homes and to their council fires. (XL–40, TLL).

Rights of foreign nations

73 The soil of the earth from one end of the land to the other is the property of the people who inhabit it. By birthright the Oñgwehonweh (Original beings) are the owners of the soil which they own and occupy and none other may hold it. The same law has been held from the oldest times.

The Great Creator has made us of the one blood and of the same soil he made us and as only different tongues constitute different nations he established different hunting grounds and territories and made boundary lines between them. (LXIX–69, TLL).

74 When any alien nation or individual is admitted into the Five Nations the admission shall be understood only to be a temporary one. Should the person or nation create loss, do wrong or cause suffering of any kind to endanger the peace of the Confederacy,

the Confederate Lords shall order one of their war chiefs to reprimand him or them and if a similar offence is again committed the offending party or parties shall be expelled from the territory of the Five United Nations. (XXVI–119, EUC).

75 When a member of an alien nation comes to the territory of the Five Nations and seeks refuge and permanent residence, the Lords of the Nation to which he comes shall extend hospitality and make him a member of the nation. Then shall he be accorded equal rights and privileges in all matters except as after mentioned. (XXXVII–120, EUC).

76 No body of alien people who have been adopted temporarily shall have a vote in the council of the Lords of the Confederacy, for only they who have been invested with Lordship titles may vote in the Council. Aliens have nothing by blood to make claim to a vote and should they have it, not knowing all the traditions of the Confederacy, might go against its Great Peace. In this manner the Great Peace would be endangered and perhaps be destroyed. (XXXVIII–121, EUC).

77 When the Lords of the Confederacy decide to admit a foreign nation and an adoption is made, the Lords shall inform the adopted nation that its admission is only temporary. They shall also say to the nation that it must never try to control, to interfere with or to injure the Five Nations nor disregard the Great Peace or any of its rules or customs. That in no way should they cause disturbance or injury. Then should the adopted nation disregard these injunctions, their adoption shall be annulled and they shall be expelled.

The expulsion shall be in the following manner: The council shall appoint one of their War Chiefs to convey the message of annulment and he shall say, "You (naming the nation) listen to me while I speak. I am here to inform you again of the will of the Five Nations' Council. It was clearly made known to you at a former time. Now the Lords of the Five Nations have decided to expel you and cast you out. We disown you now and annul your adoption. Therefore you must look for a path in which to go and lead away all your people. It was you, not we, who committed wrong and caused this sentence of annulment. So then go your way and depart from the territory of the Five Nations and from the Confederacy." (XXXIX–122, EUC).

78 Whenever a foreign nation enters the Confederacy or accepts the Great Peace, the Five Nations and the foreign nation shall

enter into an agreement and compact by which the foreign nation shall endeavor to pursuade other nations to accept the Great Peace. (XLVI–46, TLL).

Rights and powers of war

79 Skanawatih shall be vested with a double office, duty and with double authority. One-half of his being shall hold the Lordship title and the other half shall hold the title of War Chief. In the event of war he shall notify the five War Chiefs of the Confederacy and command them to prepare for war and have their men ready at the appointed time and place for engagement with the enemy of the Great Peace. (I–70, SPW).

80 When the Confederate Council of the Five Nations has for its object the establishment of the Great Peace among the people of an outside nation and that nation refuses to accept the Great Peace, then by such refusal they bring a declaration of war upon themselves from the Five Nations. Then shall the Five Nations seek to establish the Great Peace by a conquest of the rebellious nation. (II–71, SPW).

81 When the men of the Five Nations, now called forth to become warriors, are ready for battle with an obstinate opposing nation that has refused to accept the Great Peace, then one of the five War Chiefs shall be chosen by the warriors of the Five Nations to lead the army into battle. It shall be the duty of the War Chief so chosen to come before his warriors and address them. His aim shall be to impress upon them the necessity of good behavior and strict obedience to all the commands of the War Chiefs. He shall deliver an oration exhorting them with great zeal to be brave and courageous and never to be guilty of cowardice. At the conclusion of his oration he shall march forward and commence the War Song and he shall sing:

Now I am greatly surprised
And, therefore, I shall use it,—
The power of my War Song.
I am of the Five Nations
And I shall make supplication
To the Almighty Creator.
He has furnished this army.
My warriors shall be mighty

In the strength of the Creator.[1]
Between him and my song they are
For it was he who gave the song
This war song that I sing!
(III–72, SPW).

82 When the warriors of the Five Nations are on an expedition against an enemy,. the War Chief shall sing the War Song as he approaches the country of the enemy and not cease until his scouts have reported that the army is near the enemies' lines when the War Chief shall approach with great caution and prepare for the attack. (IV–73, SPW).

83 When peace shall have been established by the termination of the war against a foreign nation, then the War Chief shall cause all the weapons of war to be taken from the nation. Then shall the Great Peace be established and that nation shall observe all the rules of the Great Peace for all time to come. (V–74, SPW).

84 Whenever a foreign nation is conquered or has by their own will accepted the Great Peace their own system of internal government may continue, but they must cease all warfare against other nations. (VI–75, SPW).

85 Whenever a war against a foreign nation is pushed until that nation is about exterminated because of its refusal to accept the Great Peace and if that nation shall by its obstinacy become exterminated, all their rights, property and territory shall become the property of the Five Nations. (VII–76, SPW).

86 Whenever a foreign nation is conquered and the survivors are brought into the territory of the Five Nations' Confederacy and placed under the Great Peace the two shall be known as the Conqueror and the Conquered. A symbolic relationship shall be devised and be placed in some symbolic position. The conquered nation shall have no voice in the councils of the Confederacy in the body of the Lords. (VIII–77, SPW).

87 When the War of the Five Nations on a foreign rebellious nation is ended, peace shall be restored to that nation by a withdrawal of all their weapons of war by the War Chief of the Five Nations. When all the terms of peace shall have been agreed upon a state of friendship shall be established. (IX–78, SPW).

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[1] It will be recalled that when the Eries demanded by what power the Five Nations demanded their surrender, the Iroquois replied "The Master of Life fights for us!"

88 When the proposition to establish the Great Peace is made to a foreign nation it shall be done in mutual council. The foreign nation is to be persuaded by reason and urged to come into the Great Peace. If the Five Nations fail to obtain the consent of the nation at the first council a second council shall be held and upon a second failure a third council shall be held and this third council shall end the peaceful methods of persuasion. At the third council the War Chief of the Five Nations shall address the Chief of the foreign nation and request him three times to accept the Great Peace. If refusal steadfastly follows the War Chief shall let the bunch of white lake shells drop from his outstretched hand to the ground and shall bound quickly forward and club the offending chief to death. War shall thereby be declared and the War Chief shall have his warriors at his back to meet any emergency. War must continue until the contest is won by the Five Nations (X–79, SPW).

89 When the Lords of the Five Nations propose to meet in conference with a foreign nation with proposals for an acceptance of the Great Peace, a large band of warriors shall conceal themselves in a secure place safe from the espionage of the foreign nation but as near at hand as possible. Two warriors shall accompany the Union Lord who carries the proposals and these warriors shall be especially cunning. Should the Lord be attacked, these warriors shall hasten back to the army of warriors with the news of the calamity which fell through the treachery of the foreign nation. (XI–80, SPW).

90 When the Five Nations' Council declares war any Lord of the Confederacy may enlist with the warriors by temporarily renouncing his sacred Lordship title which he holds through the election of his women relatives. The title then reverts to them and they may bestow it upon another temporarily until the war is over when the Lord, if living, may resume his title and seat in the Council. (XII–82, SPW).

91 A certain wampum belt of black beads shall be the emblem of the authority of the Five War Chiefs to take up the weapons of war and with their men to resist invasion. This shall be called a war in defense of the territory. (XIV–83, SPW).

Treason or secession of a nation

92 If a nation, part of a nation, or more than one nation within the Five Nations should in any way endeavor to destroy the Great Peace by neglect or violating its laws and resolve to dissolve the

Confederacy, such a nation or such nations shall be deemed guilty of treason and called enemies of the Confederacy and the Great Peace.

It shall then be the duty of the Lords of the Confederacy who remain faithful to resolve to warn the offending people. They shall be warned once and if a second warning is necessary they shall be driven from the territory of the Confederacy by the War Chiefs and his men. (III–86, EUC).

Rights of the people of the Five Nations

93 Whenever a specially important matter or a great emergency is presented before the Confederate Council and the nature of the matter affects the entire body of Five Nations, threatening their utter ruin, then the Lords of the Confederacy must submit the matter to the decision of their people and the decision of the people shall affect the decision of the Confederate Council. This decision shall be a confirmation of the voice of the people. (XV–84, SPW).

94 The men of every clan of the Five Nations shall have a Council Fire ever burning in readiness for a council of the clan. When it seems necessary for a council to be held to discuss the welfare of the clans, then the men may gather about the fire. This council shall have the same rights as the council of the women. (V–88, EUC).

95 The women of every clan of the Five Nations shall have a Council Fire ever burning in readiness for a council of the clan. When in their opinion it seems necessary for the interest of the people they shall hold a council and their decision and recommendation shall be introduced before the Council of Lords by the War Chief for its consideration. (IV–87, EUC).

96 All the Clan council fires of a nation or of the Five Nations may unite into one general council fire, or delegates from all the council fires may be appointed to unite in a general council for discussing the interests of the people. The people shall have the right to make appointments and to delegate their power to others of their number. When their council shall have come to a conclusion on any matter, their decision shall be reported to the Council of the Nation or to the Confederate Council (as the case may require) by the War Chief or the War Chiefs. (VI–89, EUC).

97 Before the real people united their nations, each nation had its council fires. Before the Great Peace their councils were held. The five Council Fires shall continue to burn as before and they

are not quenched. The Lords of each nation in future shall settle their nation's affairs at this council fire governed always by the laws and rules of the council of the Confederacy and by the Great Peace. (VII–90, EUC).

98 If either a nephew or a niece see an irregularity in the performance of the functions of the Great Peace and its laws, in the Confederate Council or in the conferring of Lordship titles in an improper way, through their War Chief they may demand that such actions become subject to correction and that the matter conform to the ways prescribed by the laws of the Great Peace. (LXVII–67, TLL).

Religious ceremonies protected

99 The rites and festivals of each nation shall remain undisturbed and shall continue as before because they were given by the people of old times as useful and necessary for the good of men. (XVI–99, EUC).

100 It shall be the duty of the Lords of each brotherhood to confer at the approach of the time of the Midwinter Thanksgiving and to notify their people of the approaching festival. They shall hold a council over the matter and arrange its details and begin the Thanksgiving five days after the moon of Dis-ko-nah is new. The people shall assemble at the appointed place and the nephews shall notify the people of the time and the place. From the beginning to the end the Lords shall preside over the Thanksgiving and address the people from time to time. (XVII–100, EUC).

101 It shall be the duty of the appointed managers of the Thanksgiving festivals to do all that is needful for carrying out the duties of the occasions.

The recognized festivals of Thanksgiving shall be the Midwinter Thanksgiving, the Maple or Sugar-making Thanksgiving, the Raspberry Thanksgiving, the Strawberry Thanksgiving, the Cornplanting Thanksgiving, the Corn Hoeing Thanksgiving, the Little Festival of Green Corn, the Great Festival of Ripe Corn and the complete Thanksgiving for the Harvest.

Each nation's festivals shall be held in their Long Houses. (XVIII–101, EUC).

102 When the Thanksgiving for the Green Corn comes the special managers, both the men and women, shall give it careful attention and do their duties properly. (XIX–102, EUC).

103 When the Ripe Corn Thanksgiving is celebrated the Lords of the Nation must give it the same attention as they give to the Midwinter Thanksgiving. (XX–103, EUC).

104 Whenever any man proves himself by his good life and his knowledge of good things, naturally fitted as a teacher of good things, he shall be recognized by the Lords as a teacher of peace and religion and the people shall hear him. (X–93, EUC).

The installation song

105 The song used in installing the new Lord of the Confederacy shall be sung by Adodarhoh and it shall be:

"Haii, haii Agwah wi-yoh
" " A-kon-he-watha,
" " Ska-we-ye-se-go-wah
" " Yon-gwa-wih
" " Ya-kon-he-wa-tha

Haii, haii, It is good indeed
" " (That) a broom,—
" " A great wing,
" " It is given me
" " For a sweeping
instrument.

(LVIII–58, TLL).

106 Whenever a person properly entitled desires to learn the Pacification Song he is privileged to do so but he must prepare a feast at which his teachers may sit with him and sing. The feast is provided that no misfortune may befall them for singing the song on an occasion when no chief is installed. (XXIV–107, EUC).

Protection of the house

107 A certain sign shall be known to all the people of the Five Nations which shall denote that the owner or occupant of a house is absent. A stick or pole in a slanting or leaning position shall indicate this and be the sign. Every person not entitled to enter the house by right of living within it upon seeing such a sign shall not approach the house either by day or by night but shall keep as far away as his business will permit. (IX–92, EUC).

Funeral addresses

108 At the funeral of a Lord of the Confederacy, say: "Now we become reconciled as you start away. You were once a Lord of the Five Nations' Confederacy and the United People trusted you. Now we release you for it is true that it is no longer possible for us to walk about together on the earth. Now, therefore, we lay it (the body) here. Here we lay it away. Now then we say to you, 'Persevere onward to the place where the Creator dwells in peace. Let not the things of the earth hinder you. Let nothing that transpired while yet you lived hinder you. In hunting you once took delight; in the game of Lacrosse you once took delight and in the feasts and pleasant occasions your mind was amused, but now do not allow thoughts of these things to give you trouble. Let not your relatives hinder you and also let not your friends and associates trouble your mind. Regard none of these things.'

"Now then, in turn, you here present who were related to this man and you who were his friends and associates, behold the path that is yours also! Soon we ourselves will be left in that place. For this reason hold yourselves in restraint as you go from place to place. In your actions and in your conversation do no idle thing. Speak not idle talk neither gossip. Be careful of this and speak not and do not give way to evil behavior. One year is the time that you must abstain from unseemly levity but if you can not do this for ceremony, ten days is the time to regard these things for respect."

109 At the funeral of a War Chief, say:

"Now we become reconciled as you start away. You were once a war chief of the Five Nations' Confederacy and the United People trusted you as their guard from the enemy. (The remainder is the same as the address at the funeral of a Lord). (XXVII–110, EUC).

110 At the funeral of a Warrior say:

"Now we become reconciled as you start away. Once you were a devoted provider and protector of your family and you were ever ready to take part in battles for the Five Nations' Confederacy. The United People trusted you. (The remainder is the same as the address at the funeral of a Lord). (XXVIII–111, EUC).

111 At the funeral of a young man, say:

"Now we become reconciled as you start away. In the beginning of your career you are taken away and the flower of your life is withered away. (The remainder is the same as the address at the funeral of a Lord). (XXIX–112, EUC).

112 At the funeral of a chief woman say:

" Now we become reconciled as you start away. You were once a chief woman in the Five Nations' Confederacy. You once were a mother of the nations. Now we release you for it is true that it is no longer possible for us to walk about together on the earth. Now, therefore, we lay it (the body) here. Here we lay it away. Now then we say to you, ' Persevere onward to the place where the Creator dwells in peace. Let not the things of the earth hinder you. Let nothing that transpired while you lived hinder you. Looking after your family was a sacred duty and you were faithful. You were one of the many joint heirs of the Lordship titles. Feastings were yours and you had pleasant occasions. . . .' (The remainder is the same as the address at the funeral of a Lord). (XXX–113, EUC).

113 At the funeral of a woman of the people, say:

" Now we become reconciled as you start away. You were once a woman in the flower of life and the bloom is now withered away. You once held a sacred position as a mother of the nation. (Etc.) Looking after your family was a sacred duty and you were faithful. Feastings . . . (Etc.) (The remainder is the same as the address at the funeral of a Lord.) (XXXI–114, EUC).

114 At the funeral of an infant or young woman say:

" Now we become reconciled as you start away. You were a tender bud and gladdened our hearts for only a few days. Now the bloom has withered away . . . (Etc.) Let none of the things that transpired on earth hinder you. Let nothing that happened while you lived hinder you. (The remainder is the same as the address at the funeral of a Lord). (XXXII–115, EUC).

115 When an infant dies within three days, mourning shall continue only five days. Then shall you gather the little boys and girls at the house of mourning and at the funeral feast a speaker shall address the children and bid them be happy once more, though by a death, gloom has been cast over them. Then shall the black clouds roll away and the sky shall show blue once more. Then shall the children be again in sunshine. (XXXIII–116, EUC).

116 When a dead person is brought to the burial place, the speaker on the opposite side of the Council Fire shall bid the bereaved family cheer their minds once again and rekindle their hearth fires in peace, to put their house in order and once again be in brightness for darkness has covered them. He shall say that the black clouds shall roll away and that the bright blue sky is

visible once more. Therefore shall they be in peace in the sunshine again. (XXXIV–117, EUC).

117 Three strings of shell one span in length shall be employed in addressing the assemblage at the burial of the dead. The speaker shall say:

" Hearken you who are here, this body is to be covered. Assemble in this place again ten days hence for it is the decree of the Creator that mourning shall cease when ten days have expired. Then shall a feast be made."

Then at the expiration of ten days the Speaker shall say: " Continue to listen you who are here. The ten days of mourning have expired and your minds must now be freed of sorrow as before the loss of the relative. The relatives have decided to make a little compensation to those who have assisted at the funeral. It is a mere expression of thanks. This is to the one who did the cooking while the body was lying in the house. Let her come forward and receive this gift and be dismissed from the task. In substance this shall be repeated for every one who assisted in any way until all have been remembered. (XXXV–118, EUC).

THE CODE OF DEKANAHWIDEH

TOGETHER WITH

THE TRADITION OF THE ORIGIN OF THE FIVE NATIONS' LEAGUE

Prepared by the committee of chiefs appointed by the Six Nations' Council of Grand River, Canada, and adopted by Council of Chiefs, July 3, 1900.

The committee was as follows:

Chief Peter Powless	Mohawk
Chief J. W. M. Elliott	Mohawk
Chief Nicodemus Porter	Oneida
Chief Thomas William Echo	Onondaga
Chief William Wage	Cayuga
Chief Abram Charles	Cayuga
Chief John A. Gibson	Seneca
Chief Josiah Hill	Tuscarora
Chief John Danford	Oneida of the Thames
Chief Isiah Sickles	Oneida of the Thames

INTRODUCTORY

For several hundred years the Five Nations (since 1715 the Six Nations) have existed without a written history chronicled by themselves, of their ancient customs, rites and ceremonies, and of the formation of the Iroquois League. Books have been written by white men in the past, but these have been found to be too voluminous and inaccurate in some instances.

Of the existence of the Five Nations therefore, before the formation of the League of Great Peace by Dekanahwideh, living as they did apart from one another as separate nations and having nothing in common, much might be written, but at this juncture our object will only admit of the relation of the formation of the League of the Five Nations, which as far as can be ascertained took place about the year 1390.

The purpose for which this league or confederation of the Five Nations was organized was to enable them to protect themselves against the invasion of their vast domains by other nations who

were hostile to them, and also the formation of a form of government among themselves. Ever since the birth of the league this government has existed with but very slight modifications.

The student of ethnology may find something which may be of interest to him in this record, compiled as it is by the elder ceremonial chiefs who are now among those who are ruling the people of the Six Nations as chiefs or lords, under the old régime of dynastical lords in perpetuation of that system of government by hereditary succession as it was constituted by Dekanahwideh and his associates at the time of the formation of the League of the Iroquois.

This account is not intended to be a concise history of this interesting people, but simply a record of those interesting traditions which have been for centuries handed down from father to son in connection with the formation of the league.

There is no doubt in the minds of the writers of this preface that many of the ancient traditions of the Six Nations have become much modified, and some have been long relegated to oblivion owing to the fact that in the earlier history of these peoples there were for a long time no members of the various nations capable of rendering these traditions in writing and thus preserving them intact to their posterity.

It is a noteworthy fact that the League of the Five Nations (now known as the Six Nations) as constituted centuries ago by Dekanahwideh and his associates, has been followed in accordance with the rules of the confederacy as laid down by this founder of the league, and that the installation of the lords (chiefs) as rulers of the people as laid down in these unwritten rules hundreds of years ago is still strictly observed and adhered to by the chiefs of the Six Nations and their people.

With reference to the origin or birth, character and doings of Dekanahwideh as herein chronicled, it will be observed that they present an analogy or similarity to Hebrew biblical history and teachings. This is portrayed strongly in the narration of the birth of Dekanahwideh and also in certain extraordinary powers which he is attributed to have possessed.

There is little doubt that some of this influence was brought about as a result of the labors and teachings of the Jesuit fathers among them. In the early discovery of the Five Nations the Jesuit fathers made an effort to christianize them.

These precepts as taught and inculcated in the minds of the people by these missionaries have been assimilated to some extent and

wrought into their own religious belief, as well perhaps as into the story of the traditional nativity of this founder of the Iroquois Confederacy.

It was in recognition of the fact that all nations have a traditional history similar to this one (and some of them have long since become enlightened and educated to better things) which originated with these people while they were yet in a crude state (notably, for example, may be cited the English, Irish and Scotch legends and traditions) that this small fragment of Iroquois traditional history was written by the chiefs, so that they might preserve it as other nations have done.

It is only natural for a people undergoing a transition from a state of barbarism to that of civilization and christianity to evince a desire to have their past mythological legends and crude history preserved.

It was therefore at the request of, and by the authority of the Six Nations' Council, that that portion of the traditional history of this people relating to the formation of the League of the Five Nations, together with the condolence ceremonies, now used in the creation and induction into office of new chiefs as successors to deceased members of the council, was written from dictation by the ceremonial chiefs as follows: Chiefs Peter Powless, Mohawk; Nicodemus Porter, Oneida; William Wage and Abram Charles, Cayuga; John A. Gibson, Seneca; Thomas William Echo, Onondaga; and Josiah Hill, Tuscarora. Chiefs Josiah Hill and J. W. M. Elliott were appointed to act as secretaries, with the express purpose of having it published by the Department of Indian Affairs, so that the future generations of the people of the Six Nations may have preserved to them these traditions of their forefathers which otherwise in time would become lost.

Signed at Ohsweken Council House, Six Nations Reserve, Ontario, Canada, August 17, 1900.

JOSIAH HILL, *Secretary Six Nations' Council.*

J. W. M. ELLIOTT, *Mohawk Chief, Secretary of the ceremonial committee of Indian rites and customs.*

Indian words

The meanings of some of the more difficult Indian words to be found in this work are as follows:

1 A-ka-rah-ji-ko-wah—A great swamp elm

2 Ska-reh-heh-se-go-wah—The great tall tree

3 Jo-neh-rah-de-se-go-wah—The great long leaves
4 Djok-de-he-sko-na—The great white roots
5 Ka-ya-neh-renh-ko-wah—The great peace
6 Karihwiyoh—Good tidings of peace and power
7 Rodiyanesho'o—Lords or chiefs
8 Hoyane (Royaneh) — Lord or chief
9 Ehkanehdodeh—A pine tree, applied to earned or self-made chiefs
10 Kwa-ah — The mourning cry used by a chief warrior to convey the news of the death of a lord or head chief
11 Kanekonketshwaserah — The condolence ceremony used upon the death of a lord or chief

THE TRADITIONAL NARRATIVE

OF THE

ORIGIN OF THE CONFEDERATION OF THE FIVE NATIONS

COMMONLY KNOWN AS THE IROQUOIS

Together with an account of the ancient customs, usages and ceremonies in use by these nations in the choice and installation into office of their Ro-de-ya-ner-shoh (lords or chiefs), including traditions relating to the lives and characters of Dekanahwideh, the framer of the league, Hay-yonh-wa-tha (Hiawatha), the lawgiver, Tha-do-da-ho and other leaders.

The peculiar beginning of the Great Peace,[1] or the Great League of the Five Nations at a time most ancient, is here told.

The name of the place mentioned as the birthplace of Dekanahwideh[2] was called Kah-ha-nah-yenh,[3] somewhere in the neighborhood of the Bay of Quinte.

According to tradition, a woman[4] was living in that neighborhood who had one daughter of stainless character who did not travel away from home, but remained with her mother constantly, and when she had attained the age of womanhood she had held no manner of intercourse with any man. In the course of time, notwithstanding, she showed signs of conception and her mother was very much aggrieved. The mother, therefore, spoke to her daughter and said: "I am going to ask you a question and I want you to tell me the truth. What has happened to you and how is it that you are going to bear a child?" Then the daughter replied and said, "Mother I will tell you the truth, I do not know how I became with child." [5]

Then the mother said: "The reply you give me is not sufficient to remove my grief. I am sure that you did not tell me the full truth concerning what I asked you." Then the daughter replied: "I have indeed told you the whole truth concerning what you asked me." Then the sorrowing mother said: "Of a truth, my daughter, you have no love for me."

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[1] Gaya″nässhägo, in Onondaga; Gayanĕs′shä″gowa, in Seneca. Derived from Gayanĕs′shä, *A compelling rule of virtue*, and gowa, *great, exalted.*

[2] Dekanăwī′da, *Two water currents flowing together.*

[3] Kanyĕ^{n}'gĕ (Onon.), *Among the flints, Flinty peace, cf.* Hadineyĕ″ge′gă, *They are flint people.*

[4] No father or husband; that is, no male is mentioned in this family until Dekanahwideh appears.

[5] A virgin (female) is called deyĕn′nowädon'; (masc.) deha^{n}nowä′do^{n}' meaning, *He is hidden*; from nowä′do^{n}', *hidden.* Ye′wayei' is the word for *pure.*

Then she began to ill-treat her daughter, and then the daughter also began to feel aggrieved because of this ill-treatment from her mother.

It so happened that as the time approached when the daughter would deliver the child, that the mother dreamed [1] that she saw a man whom she did not know, and that he said that he appeared as a messenger to her on account of her troubled mind, caused by the condition of her daughter who had in so mysterious a manner conceived a child.

" I am here to deliver to you a message and now I will ask you to cease your grieving and trouble of mind, and the ill-treatment of your daughter from day to day because it is indeed a fact that your daughter does not know how she became with child. I will tell you what has happened. It is the wish of the Creator that she should bear a child, and when you will see the male child you shall call him Dekanahwideh. The reason you shall give him that name is because this child will reveal to men-beings (Oñg'wĕo^{n}wĕ'), the Good Tidings of Peace and Power [2] from Heaven, and the Great Peace shall rule and govern on earth, and I will charge you that you and your daughter should be kind to him becauses he has an important mission to perform in the world, and when he grows up to be a man do not prevent him from leaving home."

Then the old woman, (Iăgĕ^{n}'tci) asked the messenger, what office the child should hold.

The messenger answered and said: " His mission is for peace and life to the people both on earth and in heaven."

When the old woman woke up the next morning she spoke to her daughter and said: " My daughter, I ask you to pardon me for all the ill-treatment I have given you because I have now been satisfied that you told me the truth when you told me that you did not know how you got the child which you are about to deliver."

Then the daughter also was made glad, and when she was delivered of the child, it was as had been predicted; the child was a male child, and the grandmother called him Dekanahwideh.

The child grew up rapidly, and when he had become a young man he said: " The time has come when I should begin to perform my duty in this world. I will therefore begin to build my canoe and by tomorrow I must have it completed because there is work for me to do tomorrow when I go away to the eastward."

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[1] *She dreamed,* waagoi'shĕ^{n}dŭksĕ^{n}á. To guess the meaning of a dream, third person, plural, present, Hodinowaiya'ha.

[2] Ne"gā'ihwiio'ne"skăñ'no^{n}'khu (Seneca), literally, *The good message* (or edict), *the power.*

Then he began to build his canoe out of a white rock, and when he had completed it, Dekanahwideh said: "I am ready now to go away from home and I will tell you that there is a tree[1] on top of the hill and you shall have that for a sign whenever you wish to find out whether I shall be living or dead. You will take an axe and chop the tree and if the tree flows blood[2] from the cut, you will thereby know that I am beheaded and killed, but if you find no blood running from this tree after you have chopped a chip from it, then you may know that my mission was successful. The reason that this will happen is because I came to stop forever the wanton shedding of blood among human beings."

Then Dekanahwideh also said: "Come to the shore of the lake and see me start away."

So his mother and his grandmother went together with him and helped to pull the boat to the lake and as they stood at the lake, Dekanahwideh said: "Good bye, my mothers, for I am about to leave you for I am to go for a long time. When I return I will not come this way."

Then the grandmother said "How are you going to travel since your canoe is made out of stone. It will not float."

Then Dekanahwideh said, "This will be the first sign of wonder that man will behold; a canoe made out of stone will float."

Then he bade them farewell, put his canoe in the lake and got in. Then he paddled away to the eastward and the grandmother and his mother with wonder beheld him and saw that his canoe was going swiftly. In a few moments he disappeared out of their sight.

It happened at that time a party of hunters had a camp on the south side of the lake now known as Ontario and one of the party went toward the lake and stood on the bank of the lake, and beheld the object coming toward him at a distance, and the man could not understand what it was that was approaching him; shortly afterwards he understood that it was a canoe, and saw a man in it, and the moving object was coming directly toward where he stood, and when the man (it was Dekanahwideh) reached the shore he came out of his boat and climbed up the bank.

Then Dekanahwideh asked the man what had caused them to be where they were, and the man answered and said: "We are here

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[1] Djirhonathăradadoⁿ'.

[2] That men enter into or become trees is an old Iroquois conception. The sap of the tree becomes blood that flows when the tree is injured.

for a double object. We are here hunting game for our living and also because there is a great strife in our settlement."

Then Dekanahwideh said, "You will now return to the place from whence you came. The reason that this occurs is because the Good Tidings of Peace and Friendship have come to the people, and you will find all strife removed from your settlement when you go back to your home. And I want you to tell your chief that the Ka-rih-wi-yoh[1] (Good Tidings of Peace and Power) have come and if he asks you from whence came the Good Tidings of Peace and Power, you will say that the Messenger of the Good Tidings of Peace and Power will come in a few days.

Then the man said: "Who are you now speaking to me?"

Dekanahwideh answered: "It is I who came from the west and am going eastward and am called Dekanahwideh in the world."

Then the man wondered and beheld his canoe and saw that his canoe was made out of white stone.

Then Dekanahwideh said, "I will go and visit Tyo-den-he deh[2] first." Dekanahwideh then went down the bank and got into his boat, and passed on. Then the man also turned away and went home, and when he came back to the camp he said: "I saw a strange man coming from the lake with a canoe made out of white stone and when he landed he came up the bank and I had a conversation with him. First, he asked me where I came from and when I told him he understood everything.[3] Then he said: "You will all go home for there is now peace, and all strife has been removed from the settlement."

Then the party went home and as soon as they reached home, they went and told the Royaner[4] (lord) and said that the Good Tidings of Peace and Power had come. Then the lord asked the speaker who told him the message and then he said that he saw a man who was called Dekanahwideh in the world. Then the lord asked him from whence the Good Tidings of Peace and Strength were coming.

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[1] Karhihwiio, or in Seneca, Ne''Gā'ihwiio, meaning a proclamation of good [illegible] iterally the word is interpreted, *A good message.* The missionaries use the word gā-i-hwi-io for *Gospel.* The power of the new civil government is called skĕñ'noⁿ', meaning *inherent potence.*

[2] Tiodenhe'dĕ, meaning He (having died) lives again, cf. Siga'hedŭs, *He resurrects,* used as a name for Christ.

[3] Dekanawida is reputed to have been a clairvoyant.

[4] Royaner is hoya'ne in Seneca. The Mohawk root-equivalent is Ya''nerhe. Royaner means *excellent, noble, good, exalted, pure.* Thus as a title the name is translated *Lord.* Missionaries so use the name, cf. Hale Book of Rites, p. 65.

Then the man said: "It is coming and will come soon."

Then the lord said: "Where did you see the man?" He replied, "I saw him in the lake with his canoe; he came from the west and he is going eastward."

Then the lord began to wonder and said that he thought the settlement should remain in silence, for all would be glad and satisfied.

Dekanahwideh continued his journey and came to where the great wizard Toh-do-dah-ho[1] lived. This man was possessed with great power as a wizard and no man could come to him without endangering his life and it is related that even the fowls of the air whenever they flew directly over his place of abode would die and fall down on his premises, and that if he saw a man approaching him he was sure to destroy him or kill him. This man was a cannibal, and had left the settlement to which he belonged for a long time and lived by himself in an isolated place.

Dekanahwideh came[2] and approached the abode of the cannibal and saw him carrying a human body into his house and shortly he saw him come out again and go down to the river and draw some water. Dekanahwideh went closer and when he had come to the house he went up onto the roof and from the chimney opening[3] he looked in and saw the owner come back with a pail of water, put up a kettle on the fireplace to cook his meal and after it was cooked he saw him take the kettle from the fire and place it at the end of the fireplace and say to himself, "I suppose it is now time for me to have my meal and after I am finished I will go where I am required on business."

Dekanahwideh moved still closer over the smoke hole and looked straight down into the kettle. The man Tah-do-dah-ho was then moving around the house and when he came back to take some of the meat from the kettle he looked into it and saw that a man was looking at him from out of the kettle. This was the reflection of Dekanahwideh. Then the man Tah-do-dah-ho moved back and sat down near the corner of the house and began to think seriously and he thought that it was a most wonderful thing which had happened. He said to himself that such a thing had never occurred before as long as he had been living in the house. "I did not

[1] Thadoda'ho.

[2] He came on a tour of inspection. The Onondaga version says it was Hiawatha.

[3] Albert Cusick, the Onondaga informant, says this incident is an interpolation.

know that I was so strange a man," he said. "My mode of living must be wrong." Then he said: "Let me look again and be sure that what I have seen is true." Then he arose, went to the kettle and looked into it again, and he saw the same object — the face of a great man and it was looking at him. Then he took the kettle and went out and went toward the hillside and he emptied it there.

Then Dekanahwideh came down from the roof and made great haste toward the hillside, and when Tha-do-dah-ho came up the hill he met Dekanahwideh.

Dekanahwideh asked Tah-do-dah-ho where he came from and he said, "I had cooked my meal and I took the kettle from the fire and placed it on the floor. I thought that I would take some of the meat out of the kettle and then I saw a man's face looking at me from the kettle. I do not know what had happened; I only know such a thing never occurred to me before as long as I have been living in this house. Now I have come to the conclusion that I must be wrong in the way I am and the way I have been living. That is why I carried the kettle out of my house and emptied it over there by the stump. I was returning when I met you." Then he said, "From whence did you come?"

Dekanahwideh answered, "I came from the west and am going eastward."

Then the man said, "Who are you that is thus speaking to me?"

Then Dekanahwideh said, "It is he who is called Dekanahwideh in this world." Dekanahwideh then asked: "From whence have you come?"

The man then said: "There is a settlement to which I belong but I left that settlement a long time ago."

Then Dekanahwideh said, "You will now return, for peace and friendship have come to you and your settlement and you have now repented the course of wrong doing which you pursued in times past. It shall now also occur that when you return to your settlement you, yourself, shall promote peace and friendship for it is a fact that peace is now ruling in your settlement and I want you to arrange and settle all matters." Then Dekanahwideh also said: "I shall arrive there early tomorrow morning. I shall visit the west first. I shall visit there the house of the woman, Ji-kon-sah-seh. The reason why I shall do this (go and visit this woman first) is because the path passes there which runs from the east to the west."

Then after saying these words Dekanahwideh went on his way and arrived at the house of Ji-kon-sah-seh and said to her that he

had come on this path which passed her home and which led from the east to the west, and on which traveled the men of blood-thirsty and destructive nature.

Then he said unto her, "It is your custom to feed these men when they are traveling on this path on their war expeditions." He then told her that she must desist from practising this custom. He then told her that the reason she was to stop this custom was that the Karihwiyoh[1] or Good Tidings of Peace and Power had come. He then said: "I shall, therefore, now change your disposition and practice." Then also, "I now charge you that you shall be the custodian of the Good Tidings of Peace and Power, so that the human race may live in peace in the future." Then Dekanahwideh also said, "You shall therefore now go east where I shall meet you at the place of danger (to Onondaga), where all matters shall be finally settled and you must not fail to be there on the third day. I shall now pass on in my journey."

Then he journeyed on a great way and went to another settlement. Here he inquired who their Royaner was and after he had ascertained his abode he went to his home and found him, and when they met, Dekanahwideh said, "Have you heard that the Good Tidings of Peace and Power are coming?" The lord then said: "I truly have heard of it."

Then Dekanahwideh asked him what he thought about it.

Then the lord said, "Since I have heard of the good news I have been thinking about it and since then I have not slept." Then Dekanhwideh said, "It is now at hand — that which has been the cause of your sleeplessness."

Then Dekanahwideh said, "You shall hereafter be called Hayyonh-wa-tha[2] (Hiawatha)."

Then the lord said, "To whom am I speaking?" Dekanahwideh answered and said: "I am the man who is called on earth by the name of Dekanahwideh, and I have just come from the west and am now going east for the purpose of propagating peace, so that the shedding of human blood might cease among you."

Then the Lord Hahyonhwatha asked, "Will you wait until I go and announce the news to my colleagues?" Dekanahwideh then

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[1] Djikonsă'sĕ', *The wild cat* (fat faced), known as the "mother of nations." This was the most honored female title among the Huron Iroquois. She is sometimes call the Peace Queen. She was of the Neuter Nation and her lodge was on the east side of the Niagara, at Kai-a-n̄eu-ka. Often she was termed Ye-go-wa-neh, the great woman.

[2] Haiyo^{n}hwat'hă, meaning *He has misplaced something but knows where to find it.*

said that he could wait as he was on this good mission. Then the Lord Hahyonhwatha announced to his colleagues and people that they assemble to hear Dekanahwideh, and when they were assembled Hahyonhwatha asked Dekanahwideh what news he had for the people. Dekanahwideh answered that the proclamation of the Good Tidings of Peace and Power had arrived and that he had come on a mission to proclaim the Good News of Peace and Power that bloodshed might cease in the land, as the Creator, he had learned, never intended that such should ever be practised by human beings.

Lord Hahyonhwatha answered the people: " We have now heard the Good News of Peace and Power from this man Dekanahwideh." He then turned and asked his colleagues and all the people what answer they should give. Then one of the chief warriors asked: " What shall we do with the powerful tribes on the east and on the west[1] of our villages who are always hostile to us?"

Then Dekanahwideh answered and said that the hostile nations referred to had already accepted the Good News of Peace and Power.

Then the chief warrior answered and said: " I am still in doubt and I would propose (as a test of power) that this man (Dekanahwideh) climb up a big tree by the edge of a high cliff and that we then cut the tree down and let it fall with him over the cliff,[2] and then if he does not die I shall truly believe the message which he has brought us."

Then the deputy chief warrior said: " I also am of the same opinion and I approve of the suggestion of the chief warrior."

Then Dekanahwideh said: " I am ready and most willingly accede to your request, because the Good News of Peace and Power has come unto us, I now confidently place myself in your hands."

Then the lord said: " It has now been decided. We will therefore all go to where the tree stands." They then started to go there and when they arrived where the tree stood, the lord said: " We have now arrived where the tree that we have decided upon stands."

Then the chief warrior said to Dekanahwideh: " I made this proposal and therefore you will now climb this tree so that it will

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[1] To the west of the Onondagas were the Seneca and Cayuga nations; to the east the Oneida and Mohawk. It is possible, however, that the New England Indians on the east and the Neuters on the west were meant by this paragraph. Consult J. D. Prince, Wampum Records of the Passamaquoddy Documents, Annals N. Y. Acad. Sci. No. 15, p. 369-77. 1898.

[2] The Newhouse version (q.v.) gives more details of this incident.

be a sign of proof, and the people may see your power. If you live to see tomorrow's sunrise then I will accept your message."

Then Dekanahwideh said, "This shall truly be done and carried out." He then climbed the tree and when he had reached the top of the tree[1] he sat down on a branch, after which the tree was cut down, and it fell over the cliff with him.

Then the people kept vigilant watch so that they might see him, but they failed to see any signs of him. Then the chief warrior said, "Now my proposition has been carried out and Dekenahwideh has disappeared and so now we will vigilantly watch at sunrise tomorrow morning. Then the Lord Hahyonhwatha said, "We shall now return home."

Now when the new day dawned one of the warriors arose before sunrise and at once went to the place where the tree had been cut and when he had arrived there he saw at a short distance a field of corn, and near by the smoke from a fire[2] toward which the warrior went. When he arrived there he saw a man sitting by the fire and after seeing the man he at once returned to the Lord Hahyonhwatha and when he arrived there he said that he had seen the man sitting by the fire, and that it was he who was on the tree which was cut the evening before.

Then Hahyonhwatha charged him to convey these tidings to his colleagues and all the people and in a short time all the people had assembled. Then the Lord Hahyonhwatha said, "We will now call Dekanahwideh," and he then commissioned the chief warrior and the deputy chief warrior to go after him and they went to where Dekanahwideh had his fire and when they arrived they told him that the Lord Hahyonhwatha had sent them to bring him and that they would escort him to the home of Hahyonhwatha.

Then Dekanahwideh said: "It is right. I shall go with you."

They then returned and when they arrived back at the abode of Hahyonhwatha, the chief warrior spoke and said, "We have returned with Dekanahwideh, and he is now in your charge." Lord Hahyonhwatha then said: "I am now surely ready to fully accept the Good News of Peace and Power, and it now rests with you as your opinion in this matter."

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[1] This event took place on the cliff overlooking the lower falls of the Mohawk. The tree was a bitter hickory, (gŭs′thik), which stood at the doorway of a woman named De′siio‘. When Dekanawida climbed the tree he sang the air of "the six songs of the pacification hymn."

[2] The column of smoke from Dekanawida's fire is said always to have "pierced the sky." The term is, Wagayĕ^{n}gwa′i‘dĕ^{n}wagaiyaestă′, *It forms smoke, smoke pierces the sky.*

The chief warrior then said: "I was in great doubt, but have now truly concluded to accept the Good News of Peace and Power." Then Royaner (Lord) Hahyonhwatha said: "Now faithfully see these matters are settled and finished."

Then he further said: "Dekanahwideh, you may now listen to the answer we have concluded to give you. We have received the message which you brought us, and we have jointly concluded to accept the message of Good News of Peace and Power and we have now concluded all we have to say, and the matter shall now rest with you entirely."

Dekanahwideh then said: "This day is early and yet young, so is the new mind also tender and young, so also is the Good Tidings of Peace and Power, and as the new sun of Good Tidings of Peace and Power arose, so it will proceed on its course and prosper; so also will the young mind, and the Good Tidings of Peace and Power shall prevail and prosper. Therefore in the future your grandchildren forever shall live in peace."

Then Dekanahwideh answered again: "You, chief warrior, you have had power in warfare, but now this is all changed. I now proclaim that since you had doubts, you shall be hereafter known in the land by the name of Tha-ha-rih-ho-ken (De-ka-ri-ho-ken),[1] which means doubting or hesitating over two things as to which course to adopt."

And Dekanahwideh said: "You, the deputy chief warrior, I charge you that you shall be called and known hereafter in the land by the name of Sa-de-ga-rih-wa-den[2] (one-who-respects-all-matters-as-important-equally) because you truly have concurred in and justly confirmed all that you have heard."

Then Dekanahwideh also said: "I shall now pass on and go east, and we shall meet again tomorrow[3] to add to what we have already accomplished."

Then Dekanahwideh passed on in his journey.

Then in Lord Hahyonhwatha's family composed of three[4] daughters, the eldest was taken ill and in a little time she died.[5]

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[1] In Onondaga, Degaihō'kĕn'. His name appears first on the roll of "Rodiyaner."

[2] Tcă'dekaiiwāt'dĕ, sometimes translated, *Two stories diverging in conclusions.*

[3] "Tomorrow," or "on another day" frequently means the next year. Dekanawida in going east possibly went to the Abenaki or other New England Indians. See Prince, *op. cit.*

[4] Newhouse says seven.

[5] A Mohawk account. Cf. Newhouse, who says the daughters all perished through the witchcraft of Osī'no'. One account says that he took the form

The mind of Hahyonhwatha was troubled. His colleagues and the people assembled at his home and condoled with him and admonished him to forget his sorrow, and he acceded to their desire.

Shortly afterwards the second daughter took sick and in a short time died. Then the sorrow and trouble of the Lord Hahyonhwatha was greatly increased, and again his colleagues and people assembled at his abode and again they tried to induce him to forget his sorrow and trouble, but he could not answer them. So Deharihoken said: "I will not tell you my mind (my purpose). I think that we should look for something which would console the mind of our lord in his trouble and bereavement." Then he also said: "I would lay before you warriors, for your consideration, that you cheer him by playing a game of lacrosse." [1]

Then Sadekarihwadeh said: "I will now tell you my mind, first let the people all assemble to console him. This shall be done as alas our lord has now only one daughter left alive."

Then Dekarihoken confirmed all that Sadekarihwadeh had said.

Then the people assembled at the home of the Lord Hahyonhwatha and they spoke unto him words of condolence that he might forget his grief and bereavement.

But the lord did not answer them. So then the warriors decided that they would play a game of lacrosse in order to cheer him and during the time that they were playing, the last daughter of Hahyonhwatha came out of the family abode to go after some water and when she had gone half way to the spring she saw flying high up in the air above a beautiful bird.[2] She paused in her journey and the bird flew downwards toward her. She cried out aloud, being frightened, and said, "O, see this bird!" after which she ran away.

Then the warriors saw it and as it was then flying low, the warriors followed it, and as they were looking at the bird they did not notice the daughter of Hahyonhwatha before them and in their haste they ran over and trampled her to death, and it transpired that the daughter of Hahyonhwatha was with child.

Then Sadekarihwadeh went and told Hahyonhwatha that a strange bird called Teh-yoh-ronh-yoh-ron (a high flying bird which

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of a screech owl and conjured from a tree overlooking the daughters' lodge; another that he became a poison shadow at the bottom of a spring.

[1] Each game had a reputed medicinal effect.

[2] This was the magic Hă'goks, sometimes called "the wampum eagle." Another descriptive name is given later in the text.

pierces the skies) had come amongest them and that it was due to the visit of the bird that his daughter was killed.

Then Hahyonhwatha answered sadly and said: "I have now lost all my daughters and in the death of this, my last daughter, you have accidently and unwittingly killed two beings." [1]

And Hahyonhwatha further said: "I must now go away to the west," and he started immediately on his way. He met Dekanahwideh on the trail and Dekanahwideh warned him of the danger on his way, especially with reference to a certain man who was watching, saying as follows:

"There is danger in front of you, there is a man watching your way in front of you. It is necessary for you to approach him without his becoming aware of your coming until you get to him. If you can get up to him while he is unaware of your approach then we shall surely prosper in our mission. You will then speak to him and ask him what thing he is watching for. He will answer you and say that he is watching to protect the fields of corn as the people of other nations and also animals destroy the crops and he is watching therefore that the crops might be preserved, so that the children might live from the harvest."

Then Hahyonhwatha proceeded on his journey and when he arrived where the man was sitting beside a fire near a big tree and watching; he quickly spoke, asking, "What are you doing?" And the man answered and said: "I am watching the fields of corn to protect them from other nations and also from animals that our children might live from the harvest."

Hahyonhwatha then said to the man: "Return home now and tell your lord that the Good News of Peace and Power has come." So he returned and told his Lord the message given to him by Hahyonhwatha. Then the lord said: "Who is it who told you this strange news?" Then the man who had been watching said: "A man suddenly appeared to me when I was watching the fields of corn and he told me the news."

Hahyonhwatha went to the other end of the corn field and there met Dekanahwideh. Dekanahwideh said: "We have now announced the (Ka-ya-ne-reh) Good Tidings of Peace and Power, therefore you shall abide in this hut near these corn fields, which you will only leave when you receive an invitation from the people.

[1] Other versions say that this event took place before Hiawatha met Dekanawida, his grief over his losses, driving him into a self-imposed exile, during which he lamented all evil conditions. Later he met Dekanawida. A. Cusick, and Baptist Thomas, New York Onondagas, both concurred in this.

You must not go unless the invitation is official. A woman shall first come to you early tomorrow morning who will be the first to see you, then you shall cut and prepare some elderberry twigs.[1] You shall cut them into pieces and remove the heart pulp and then you shall string them up." "Then the lord (Royaner) shall send a messenger to you to invite you, but you must not accept the invitation until he shall send to you a string of twigs similar to your own."

Then Hahyonhwatha went on his journey and found the hut beside the cornfield and built a fire, and in the morning a woman came to the cornfield and saw the smoke from the fire at the end of the cornfield and when she arrived there she saw a man sitting with his head hanging down. Then the woman hurried home and went straightway to where the lord (Royaner) lived and when she arrived she told him that she had seen a strange man sitting beside a fire in the cornfield.

Then the lord asked her: "What thing was this man doing there?" And the woman answered and said that the man was sitting there quietly looking on the ground.[2]

Then the lord said: "This must be the man who sent the message of the Good Tidings of Peace and Power. I shall therefore now send a messenger to bring him hither."

He then summoned the chief warrior and the deputy chief warrior to come to him and when the two had come, the lord said to them: "You shall go after the man who is at the fire in the cornfield and bring him to me. The lord then said to the deputy chief warrior: "I send you to go after him," and the deputy chief warrior went to bring this man, and when he arrived at the place where the man had built the fire, he saw a man sitting there and he was looking at a string of elderberry twigs which was hanging on a pole horizontally placed in front of him.

Then the deputy chief warrior said: "I am sent after you by the lord (Royaner)."

The man did not answer and so the deputy chief warrior repeated the message of the lord three times, but the man did not give any

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[1] Wampum at first seems to have been any kind of cylindrical bead, large or small. The Mohawk name is o'tgo'rha; Seneca, o'tko'ä'. The quills of feathers and porcupines were used as wampum (o'tgo'rha). Indeed Baptist Thomas, an Onondaga informant, says porcupine quills were used and not elderberry twigs as stated in this version.

[2] Hiawatha kept repeating the phrase, äsanatcik, meaning, *they should give me a wampum token.*

reply. Then the deputy chief warrior turned and returned to the lord, and when he arrived, he said to the lord: " He did not reply."

The lord then asked: " What did you see?" Then the deputy chief warrior answered and said, " I saw a string of elderberry twigs hanging on a pole in front of him and he was looking at it." Then the lord answered and said: " I now understand; I shall therefore make a similar string out of quills which will cause him to come." The lord then made two strings of quills and put them on a thong.

The lord then said: " I have now completed the strings and you shall both go after him and bring him here. You shall therefore take these strings of quills with you to him and they shall become words and that will induce him to come. They then went on their errand and when they had arrived at the fire the chief warrior said: " The lord has again sent us after you, and this string of quills are his words which are to bring you to him."

Then Hahyonhwatha answered and said: " This is what should have been done." He then took the string of quills and said: "After I get through smoking[1] I shall go to the lord."

They then returned to the lord and when they had arrived they said that the man had now answered and that when he had finished smoking his pipe he would come.

The lord then told them to tell the people so that they would all assemble when the man should arrive.

The chief warrior and the deputy chief warrior then went to tell the people to assemble as soon as possible to the abode of the lord.

The people had therefore all assembled when Hahyonhwatha arrived. The lord said to him: " You have come amongst us and doubtless you have some important matter to convey to us. The people have already assembled and are prepared to listen to the matter which you may have to communicate to us."

Then Hahyonhwatha answered: " I have come here to deliver to you the message of Good Tidings of Peace and Power so that our children in the future may live in peace."

Then the lord said: " We shall defer answering you until the return of a certain man for whom we are waiting, but in the meantime we desire that you shall remain in our village with us."

Then Hahyonhwatha answered and said: " This can be safely

[1] To have gone in haste without a semblance of deliberation would have been considered insulting.

done as I came to you with the message of Good Tidings of Peace and Power."

Then the lord said: "I shall therefore entertain you myself. This will be done because the message which you have brought to us may be the same as the other man's for which we are waiting, and he has sent word that he is coming." Then Hahyonhwatha said: "I approve of all this."

The assembled people then dispersed and when night came the lord told Hahyonhwatha that he could sleep in the inner room. Then he (Hahyonhwatha) went in and retired. Shortly after he heard a voice outside which said: "Are you stopping here?" and Hahyonhwatha replied, "Yes." Now the voice from outside said that it was very urgent for him to come out.

So Hahyonwatha went out and he saw Dakanahwideh standing outside. Dekanahwideh then said: "It is now urgent that we proceed directly on our journey.[1] You have now accomplished all that is necessary to be done here at present; we can go to another settlement now and afterwards return. The man you are now waiting for will likely have returned by that time."

"There is one settlement left to be visited, although I have been there before and had conversation with the man. I have promised him that I will visit him again and for that reason when you left home you heard a loud toned voice in front of you saying, 'A-son-kek-ne-eh.'[2] We will now proceed on our journey."

They then went and while they were on their way Dekanahwideh said, "Let us stop here and wait a while, and you will look toward the southeast. So they stood still and Hahyonhwatha looked toward the southeast and saw the smoke arising and reaching to the sky.

Then Dekanahwideh asked: "What do you see?"

Hahyonhwatha said: "I see smoke piercing the sky."

Then Dekanahwideh answered: "That smoke which you saw is where the abode of Dyon-yon-ko is. The reason you see the smoke piercing the sky is because the Good Tidings of Peace and Power have come to the people of that settlement but unfortunately, owing to the selfishness and lack of energy of these people, the Good Tidings of Peace and Power have not prospered and have not extended to other settlements.[3] It is thus good that these people

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[1] Baptist Thomas says Hiawatha left this council because of a dispute on the part of the people, who forgot him in their effort to honor another man.

[2] "It has not yet occurred," asoñ′de'nēi'.

[3] It is said that the New England Indians (Adirhon′daks), the Cherokee (Oya′de), the Wyandott (Thăstăhetci), the Tionante (Tyonontate'ka'), the

have received the Good Tidings of Peace and Power. We shall therefore take power from them which will enable us to complete the work we have undertaken to accomplish."

They then heard the loud toned voice saying: "A-soh-kek-ne ———eh" (it is not yet; which means, impatiently waiting). Then Dekanahwideh said: "It is now very urgent for us to proceed on our journey to the place from whence this voice proceeds." They then went and they had not gone far when they came to a lake. Then Dekanahwideh said: "It is now left with you to decide what we shall do; you have seen the lake and it is beside this lake that the man lives whose loud voice you have heard saying: 'Asohkene———eh.'"

Dekanahwideh then also said: "There are two ways which we can pursue to get across the lake, and you can have your choice. We can take the boat which you see lying flat on the ground and paddle over or we can magically pass above the lake, and so get over it." Dekanahwideh also said: "That man whom you heard calling in a loud voice is able to cause the boat to upset if he sees it and the people within it to become drowned; he has ended the lives of many people in this way in the lake."[1]

Then Hahyonhwatha said: "My choice is that we pass over above the lake." Then Dekanahwideh said: "It is best to approach this man from behind; the reason we should do this is that he has been so long impatiently waiting that it would not be wise to approach him from the front and it might cause trouble." Then Dekanahwideh also said: "We shall now therefore proceed on our journey."

Then they went on their journey and arrived at the other side of the lake. They had not gone far when Hahyonhwatha saw the man sitting on a high knoll where it was his custom to sit. When silently they arrived where he was sitting, Dekanahwideh stood on the right side and Hahyonhwatha on the left. The man had not yet seen them when he called again: "A-soh-kek-ne———eh!"

Then Hahyonhwatha saw what this man was doing and as soon as the man called out in the loud voice the lake became very rough and troubled and great billows formed on its surface.

Then Dekanahwideh spoke and said: "I have now returned

Neuter Nation (Atirhagenrat), the Erie (Djikon'saseoano') and others, including the Delaware and some southern tribes, were invited into the confederacy.

[1] Onondaga lake at a point near the present village of Liverpool.

and according to my promise. I promised to bring some one with me and I have now fulfilled this promise."

Then the man who was sitting down turned around and saw Dekanahwideh and said: "Who is the man that has come with you?"

Dekanahwideh then said: "Look to your left and you will see." Then he looked to his left and saw the man standing there; then he said to the man (Hahyonhwatha): "What are you doing here?"

Hahyonhwatha answered and said: "I am standing here beside you because our minds are with you and are turned toward you, for the Good Tidings of Peace and Power have now arrived. You will therefore now see as you turn around in every direction the columns of smoke arising." [1]

Then the man raised his head and carefully looked around and he asked: "Who will accomplish this, that the Good Tidings of Peace and Power be propagated?"

Dekanahwideh said: "Tomorrow in the day time the delegates will come and approach you; then all things will be completed."

Then the man said: "I shall wait until all the delegates shall have arrived."

Then Dekanahwideh said: "We must now return but we must all meet again tomorrow."

So Dekanahwideh and Hahyonhwatha went away and returned again to the abode of the lord where Hahyonhwatha had been lodging when Dekanahwideh called him out and when they had arrived there the lord found out that Hahyonhwatha had returned. Then the lord called him in and told him that the man for whom they had been waiting had returned and said: "We are now ready to answer your message."

Then Hahyonhwatha said: "I am also now ready and I am accompanied by my coworker."

Then the lord answered and said: "You will now bring him in." Then Hahyonhwatha called Dekanahwideh and he came in.

Then the lord said: "The man for whom we have been waiting has now returned and he has delivered his message fully and according to our understanding it is the same as your message. We now understand and we therefore have now decided to accept your message."

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[1] Smoke arises from settlements of people at peace with each other. The tall column of smoke symbolized the establishment of the Gayanĕsshä''gowa.

Then Dekanahwideh said: "We shall now conclude the object of this message." He then asked the question: "To whom among us did the message of the Good Tidings of Peace and Power first come?"

The lord answered and said: "It is to the man who was guarding the cornfield."

Then Dekanahwideh said: "Where is the man? You shall now bring him here." So the lord called him in and when he had come the lord said: "This is the man who guarded the fields of corn so that our children might live on the harvest."

Dekanahwideh said: "I now ask you if you are indeed the man who guards the cornfields and what your magical power is when you are so guarding the cornfields."

Then the man answered and said: "I rely entirely on my bow and arrows and when I go to the cornfields I take all my arrows with me."

Then Dekanahwideh asked the question: "How or in what manner do you carry your power?" (meaning his bows and arrows).

The man then answered and said: "I place them in a quiver and place the quiver on my back."

Then Dekanahwideh said: "You shall now therefore be called "Oh-dah-tshe-deh"[1] (meaning, the quiver bearer), as your duty as a guardian of the cornfields is now changed because the Good News of Peace and Power has now come. Your duty hereafter shall now be to see that your children (instead of fields) shall live in peace."

Then Dekanahwideh again asked the lord: "In the past (during the long time he had been guarding the cornfields), what did you do with reference to that part of the crops which were damaged?"

Then the lord answered and said: "I used to send the warriors to gather the damaged crops and they brought them to me and I would divide the corn in equal shares among the people."

Then Dekanahwideh said: "You shall now therefore hereafter be called Ka-non-kwe-yo-da.[2] It shall therefore now be your duty to propagate the Good Tidings of Peace and Power so that your children may live in peace."

Then Dekanahwideh said: "Where is the man for whom you have been waiting?" The lord then called this man and when

[1] Odatcē″te', quiver bearer, principal Oneida chief.
[2] Kano^{n}kwe^{n}yō'do^{n}', *A row of ears of corn standing upright.*

he had arrived, Dekanahwideh said: "Are you the man for whom this people have been waiting so long to return?" Then the man answered, "I am that man." Then Dekanahwideh said: "What was the cause of your long delay in coming?" The man answered and said, "I was waiting for that other man who passed here, and who promised to return but who did not return, and while I was vigilantly watching and waiting for him I could not see him and he failed to return as promised, and when I was on the point of returning I tore down my hut which I had built, then I looked back to my home for the path by which I had come. It had been plainly open before me but now on each side of the path was the forest. I then left and came home here and then I found that already the people had all heard of the Good News which I wished to bring them, so I simply corroborate what they have already heard (from Hahyonhwatha)."

Then Dekanahwideh said: "Everything is now completed, and as you have now torn down your hut, your duty is now changed. You looked back and saw plainly the path through the forest. You shall therefore be known in the land by the name of De-yo-ha′-kwe-de.[1] Your duty shall therefore be to propagate the Good Tidings of Peace and Power so that your children in the future may live in peace." Then Dekanahwideh also said: "I will now tell you that the people through whose settlements I have passed have all accepted the Good Tidings of Peace and Power. Hahyonhwatha shall therefore now go after his colleagues and I shall now visit the settlement at the big mountain[2] and see what is happening there. I have been there before but I have not yet received an answer and what I think now is that we ought to join together in this great work for it is now urgent that it would be done for our time is getting shortened and we have only until tomorrow[3] to complete the whole compact." Then he, Dekanahwideh, also said: "It would be best to appoint two delegates to go and find the smoke."

Then Hahyonhwatha said: "Where shall we meet again?"

Dekanahwideh answered and said: "We shall meet again by the lake shore where my boat lies."[4]

Then Ohdahtshedeh spoke and said: "I shall lie across the pathway like a log and when you come to me you will come in

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1 Teyoha′gwĕñtĕ', *Hollow voice in the throat.*
2 Ganundawao, Bare Hill, the Seneca capitol.
3 The term "tomorrow" means *a year hence.*
4 At the mouth of the Oswego river; Oswē′ge^{n}', meaning, *the place of the outpouring.*

contact with a log and I shall then join with you" (meaning that he, Ohdahtshedeh, would be lying in wait for them and when they should come to the log, which means his settlement, he could accompany them). Then Ohdahtshedeh further said that he would agree to appoint two delegates to go and look for smoke (smoke means settlements).

Then Ohdahtshedeh said: "It is now left with you, the warriors, as to which of you will volunteer to go."

Then the chief warrior said: "I shall be one of those who volunteer to go." Then Ohdahtshedeh also said: "There is one more required to go; who will therefore volunteer?"

For a long time no one gave answer. Then Ohdahtshedeh asked the question anew and still again no one answered. Then Ohdahtshedeh said: "I shall ask the question once again, for the last time, and if any one desires to volunteer let him speak at once", and from the outside of the gathering a man spoke out and said that he would be one of the volunteers.

Then Dekanahwideh said, "Go and call that man who is speaking from the outside." The man was called in and he was asked to stand by the chief warrior in the meeting. Then Dekanahwideh said to the chief warrior: "You are the first to accede to the request of the lord to volunteer, therefore, your duty shall be to obey orders whenever the (lord) has any duties to give you." Then Dekanahwideh said to the warrior who was the second to volunteer: "As you came from the outside of the meeting, you shall therefore in the future be an assistant to the chief warrior in his duties, and whenever the chief warrior assigns his duties to you, you shall perform his duties and carry out his instructions." Then Dekanahwideh said: "It is now completed; you have all been assigned your duties. You will now go and search for the smoke and wherever you see smoke you shall go there and when you arrive there you shall see the lord of the settlement, then you shall tell him your message. You will say we were sent here by the lords (Ro-de-ya-ners-onh) who take you by the hand and invite you to the place of meeting. You will say to the lord you will send delegates and on their way to the conference to pass where the lord lives at the big mountain and you shall invite him to accompany you. Then if the lord asks you the place of meeting you shall say, 'by the lake where lives the Great Wizard who calls out in the loud-toned voice.'"

They then separated, the chief warrior and his assistant going on their mission, and Dekanahwideh and Hahyonhwatha going to

their own home settlements, and when Hahyonhwatha had arrived home he said, "Everything is now completed and we shall (all colleagues) now all go to the conference. You shall therefore all make ready."

The people watched the two volunteer delegates start on their mission and saw them become transformed into high-flyers (a species of hawk)[1] and they arose high in the air and soared southward and when they descended and alighted near the settlement they were retransformed and proceeded to the village.[2] Here they inquired the abode of the lord, and they were conducted to him and when they had arrived they saw a man. Then the chief warrior asked: "Are you the lord?"

And he answered and said: "I am. Are you seeking for me?"

The chief warrior then said: "Yes, truly we are looking for you."

Then the lord said: "I will now ask you upon what mission have you come here."

Then the chief warrior said: "We are sent by the lords (Rodeyanersonh) who invite you to go to the meeting place of the conference, and you are to take your power with you" (meaning peaceful intent). "You shall therefore invite the lord who lives on the great mountain to accompany you."

Then the lord spoke and said, "Where shall we meet in conference," and the chief warrior answered and said, "By the lake."

Then the lord said: "I have known about this for a long time. I shall therefore now accept your message." Then he took his pipe and said: "When I finish smoking I shall attend the conference" and the chief warrior and his assistant saw the pipe which was an exceedingly large one and larger than any pipe which they had ever seen before. They then returned to their own settlement and when they had returned Ohdahtshedeh asked, "Did you discover the smoke?" Then the chief warrior answered and said: "Everything is right, all is well, and we have discovered the object which you desired; when we saw the smoke we went there and when we arrived we found the lord and we repeated to him fully all our message, and when he had heard all, he answered and said, 'I had known about this for a long time, and knew that I was required to attend the great conference and I now therefore accept and

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[1] The two birds into which the messengers were transformed were Hă'goks' and Skadjiē'na.

[2] To the Cayuga capitol town. The Cayuga have the council name of Sononawe^{n}do'na, Great Pipe People.

approve the message.' He promised to pass on his way to the conference, the settlement at the great mountain,[1] and the people there are to accompany him to the conference."

Then Ohdahtshedeh said: "It is now time that Hahyonhwatha should return, and as soon as he returns we shall at once go to the conference."

Dekanahwideh himself had also gone to the settlement of the great mountain and when he had arrived at the abode of the lord of the settlement he said: "It is now very urgent that you should reply to the message which I have left here before."

The lord answered and said: "The chief warrior and his deputy have failed to unanimously agree with me to accept the message of Good Tidings of Peace and Power, and I am now bewildered and I am at loss to discover any course which might lead me to overcome this difficulty. The reason why we are thus placed is that the chief warrior and his deputy, who have the power and the control of the people, have disagreed with us to accept the message."

Then Dekanahwideh said: "That which has occurred with you will not make a difference. The reason why it will not make any difference is that you, being the lord, have accepted the message. You are not alone, for they are many who have now accepted the message and they will assist you to successfully consider the difficulty in which you are placed."

Then moreover Dekanahwideh said: "You will now notify the brother lord whose abode is on the *other side of the river*[2] that it is now urgent for him to come over the river, so that we might meet together here." Then the lord sent a messenger to notify the lord, whose abode was on the other side of the river, and shortly after the lord arrived at the appointed place.

Then Dekanahwideh said: "We have now all met together. I will therefore ask your mind."

Then the lord who had come from over the river spoke and said: "We lords on either side of the river have decided to accept your message which you left. The only difficulty which we have now to contend with is that our chief warrior and his deputy have failed to agree with us to accept the message, and they have the power to control the people, and we lords on either side of the

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[1] The Seneca capitol. The Senecas were divided into two bands, one of which seems to have been allied with the Erie.

[2] Probably the Genesee river. "The other lord" means the chief of the trans-Genesee Seneca.

river are totally bewildered and fail to see a way out of the difficulty." [1]

Then Dekanahwideh said: "I now fully understand everything and I will encourage you with reference to this matter which has occurred to you. You are not alone for many have accepted the message of Good Tidings of Peace and Power. Therefore, owing to that which has occurred to you, you (the lord) whose abode is on this east side of the river and to whom the message first came shall be known in the land by the name of Ska-nya-dah-ri-yoh,[2] and you, the lord who came from over the river who has agreed in mind with your colleague on this side of the river, shall be called in the land by the name of Sa-denka-ronh-yes." [3]

Then Dekanahwideh also said: "This is now completed. Now it is for you to make ready, for in a little while a man will come whom you will accompany to the conference." They then in the distance heard the man call, "A-soh-kek-ne———eh," meaning "It is not yet."

Then Hahyonhwatha distinctly heard where he was. Then Hahyonhwatha said to his colleague: "The time is now come when we should go to the conference." They then started to go to the place appointed for the conference and they arrived at the place where the log (the Lord Ohdahtshedeh) was lying across the path.

Ohdahtshedeh said: "We have been impatiently waiting for we have heard the man calling with a loud voice now for a long time. It is at the place appointed for the meeting of the conference."

Then Hahyonhwatha said: "Let us now proceed to the conference." They then went to the conference. Then Dekanahwideh said, "I shall now return to my abode and we shall all meet at the place appointed for the conference." Then the Lords Deh-ka-eh-yonh, Ji-non-dah-weh-hon [4] and Dyon-yonh-koh came from their settlement and when they arrived at the abode of Skanyadahriyoh, they said that the lords had decided and arranged that all should call here on their way to the conference and that they were to invite all to accompany them.

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1 The difficulties of the Senecas are related in all versions of this tradition. Two separate bodies of the Senecas are described in nearly all stories of the origin of the league.

2 Ganiodai'io' (Seneca), Handsome Lake.

3 Sadegai'yēs (Onondaga), or Dyădegaihyēs.

4 Djinondawē'hon'.

Then Skanyadariyoh said: "We are ready now and we have been waiting for a long time."

They then journeyed on their way to the conference. Dekanahwideh had arrived at the place of meeting first, and after him arrived Hahyonhwatha, Ohdahtshedeh and their colleagues and shortly afterwards Skanyadariyoh, Dehkaehyonh and their colleagues arrived.

After they had all assembled in conference, Dekanahwideh stood up and said:

"This conference met here composed of four nations being now assembled, you will therefore now first consider what we shall do with reference to a certain woman, our mother, who has not yet arrived." They then considered the matter and they decided that they would proceed with the business on hand and the matter would be in progress when she arrived.

Then Dekanahwideh said: "The first thing we shall do will be to cross over the lake and it shall be Hahyonhwatha and Ohdahtshedeh and Dehkaehyonh and Skanyadariyoh and Sadehkaronhyes, who are the rulers with power who shall cross first. If these lords can safely get across the lake and make peace, then you, the whole delegation, can cross. Therefore you shall now watch and you shall see a display of power when they leave the shore in their boat. I shall therefore appoint Hahyonhwatha to guide the boat."

They then entered the boat and he (Dekanahwideh) stood in front of the boat and Hahyonhwatha sat in the stern and the rest of the lords then noticed that the boat was made of white marble. Then they embarked in this boat from the shore and they had not proceeded far on their journey when they heard a voice calling out, "A-soh-kek-ne———eh," and as soon as this voice had called out a strong wind arose and caused the lake to become very rough and troubled and great billows[1] formed upon its surface and more especially around the boat. Then those in the boat became frightened and said: "We are now going to die," but Dekanahwideh spoke and said: "There is no danger because Peace has prevailed."

Then Dekanahwideh further said to the wind and lake, "Be thou quiet, Gā-hä",[2] and rest." Then the wind and the roughness of the lake ceased. They had not gone much farther when the man across the lake called out "Asohkekne———eh," and then the wind and roughness of the lake became still more violent. Then again

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[1] The lake was troubled because certain ceremonial words were spoken, making it become alive.

[2] The Wind God.

Dekanahwideh said: "You, the wind and the lake, be still, for we have not crossed the water yet." Then again the lake became calm. Then Hahyonhwatha began to paddle hard and the boat went so swiftly that when they reached the shore, the boat plowed deeply into the dry land on the shore bank.

Then Dekanahwideh said: "We will now get out of the boat for we have now arrived at the place where we desire to go." Then he got out and the other lords followed him and they continued on their journey and they had only gone a short distance when they beheld a man sitting on a high, round knoll and when they arrived where he was sitting they stood all around him and Dekanahwideh stood directly in front of him, then he spoke and said: "We have now arrived, we representing the four nations. You will therefore now answer the message which we have left here with you. These lords who now stand all around you have now accepted the Good Tidings of Peace and Power, which signifies that hereafter the shedding of human blood shall cease, for our Creator the Great Ruler never intended that man should engage in any such work as the destruction of human life. There are many who have perished in the direction you are now facing, and these lords have come to induce you to join them so that the shedding of human blood might cease and the Good Tidings of Peace and Power might prevail."

Then the man looked around and saw these men (the lords) standing all around him, but he did not answer but kept silent. Then these lords looked at his head while he was sitting on the ground and they saw his hair moving as if it were all alive and they saw that the movements of the hair greatly resembled that of serpents, and they looked at his hands and saw that his fingers were twisting and contorting continually in all directions and in all manner of shapes, and they became impatient because he would not answer the message.

Then Dekanahwideh said to Hahyonhwatha: "You shall now recross the lake and the chief warrior and De-ha-rih-ho-ken and Dyon-yonh-koh and our mother Ji-kon-sah-seh, shall accompany you back in the boat (when you return here)."

Then the man who was sitting on the ground smiled a little. Then Hahyonhwatha hurriedly went back and reembarked in the boat and recrossed the lake and when he had come to shore on the other side of the lake, they asked what had occurred.

Hahyonhwatha answered and said: "It is not yet complete, I have therefore come after the chief warrior, De-ha-rih-ho-ken and

Dyon-yonh-koh and our mother Ji-kon-sah-seh," [1] and they answered him and said: "She has now arrived."

Then all those whom he had named got into the boat. Then Hahyonhwatha said: "You will take as a sign that if we can get across the lake in safety and the lake remains calm all the way across then our message of peace will be accepted." They then embarked on the lake [2] and the boat was rapidly propelled and as they looked at the lake they saw that it was calm all the way across and they arrived on to the shore in safety, and when they had returned to where the man was sitting, Hahyonhwatha said, "Everything is completed, we are now all assembled here."

Then Dekanahwideh said: "We shall now first give thanks to the Great Ruler. We will do this because our power is now completed." He also said: "It shall be that each nation shall now have a voice in the thanksgiving and I shall therefore be the first to lead. He then exclaimed "Yo———hen!"

Then Ohdahtshedeh also repeated "Yo———hen" and after him followed Dehkaehyonh who also repeated "Yo———hen." The next in order was Skanyadahriyoh who also repeated "Yo———hen" and after him Hahyonhwatha repeated "Yo———hen."

When Dekanahwideh started to address this man, the man became troubled and after all of the lords finished addressing the man his sympathy was affected and he shed tears. Then Dekanahwideh said: "We, the delegates of all the nations who have accepted the Good Tidings of Peace and Power, are now assembled here.

"The course, therefore, that we shall now pursue is that of the representatives of each nation giving utterance to their opinion upon this matter."

Ohdahtshedeh was the first to address the assembly and he said: "I shall be the first to give utterance to my opinion upon this matter. In my opinion this man may approve of our mission if we all lay our heads before him." (This means that the nations here represented would be submissive to this man Tha-do-dah-ho).

Then Dekanahwideh and Skanyadahriyoh spoke and said: "We acquiesce to all that Ohdahtshedeh has said."

Then Dekanahwideh said to Thadodahho: "Now you will answer and state if you are satisfied with the submission of these

[1] Djikon'sase is a character who should be better known in Iroquois mythology. There are several traditions about her, in the various events of Iroquois tradition. The name passed as a title from one generation to another.

[2] Mud Lake, or Diok'to, Otisco Lake.

lords who have laid their heads before you," but even then Thadodah-ho did not answer.

Then Dekanahwideh said: "You Dyon-yonh-koh will now give utterance and express your opinion on this matter, as you now have the authority."

Then Dyon-yonh-koh spoke and said to Thadodah-ho: "The Creator, the Great Ruler, created this day which is now shedding its light upon us; he also created man and he also created the earth and all things upon it. Now look up and see the delegates of the Four Nations sitting around you, also see the chief warrior and this great woman our mother (Jiknosahseh), standing before you, all of whom have approved of this message. The lords and all the chief warriors and this great woman, our mother, have all agreed to submit the Good Tidings of Peace and Power to you, and thus if you approve and confirm the message, you will have the power and be the Fire-Keeper of our Confederate Council, and the smoke from it will arise and pierce the sky, and all the nations shall be subject to you."

Then the twisting movements of the fingers and the snakelike movements of the hair of Thadodahho ceased.

Then he spoke and said: "It is well. I will now answer the mission which brought you here. I now truly confirm and accept your message, the object of which brought you here."

THE DEER'S HORNS THE EMBLEM OF POWER

Then Dakanahwideh said: "We have now accomplished our work and completed everything that was required with the exception of shaping and transforming him (by rubbing him down), removing the snake-like hair from him and circumcising him."

The lords therefore all took part in doing this and Ohdahtshedeh was the first to rub down Thadodahho and the others followed his example so that the appearance of Thaddodahho might be like that of other men.

When this had been done then Dekanahwideh again said: "You, the chief warrior, and you, our mother, you have the control of the power (the authority), and we will now put upon him a sign, by placing upon his head the horns of a buck deer. The reason why we do this is because all people live upon the flesh of the deer, and the reason that we take the emblem of the deer horns is that this institution, the Great Peace, shall be the means of protecting our children hereafter."

Then Dekanahwideh also said: " We shall now use these symbolic deer's horns by placing them upon the heads of each other. It shall be thus then that these horns shall be placed upon the head of a man who shall be called a lord by his people — he shall have the power to rule his people." Then Dekanahwideh further said: "And now you, the chief warrior and our mother, shall place these horns upon the head of him, Thadodahho."

Then they looked and saw antlers lying on the ground in the midst of them, and Dekanahwideh said: " Pick these horns up and put them upon him." Then the mother went forward and picked them up. Then the chief warrior and the woman each grasped the horns and placed them on his head.

Then Dekanahwideh said to the man who was still sitting on the ground: " Now arise," and the man stood up.

Then Dekanahwideh said: " You, the nations who are assembled here, behold this man who stands up before us. We have now placed the deer's horns upon his head as an emblem of authority. The people shall now call him Lord Tha-do-dah-ho, in the land." Then Dekanahwideh said: " It shall now, in the future among us, the United Nations, thus be a custom that whenever a lord is to be created we shall all unite in a ceremony (such as this)."

POSITIONS OF THE CONFEDERATE LORDS

Then Dekanahwideh said: " Skanyadahriyoh and Sadehkarohyhes shall be the uncles of Dehkaehyonh. We have now formed the confederacy, and we shall now have two sets of lords, one on each side of the council fire.

" Then also Hahyonhwatha and Ohdahtshedeh, father and son, shall sit and face each other, one on each side of the council fire.

" Then Skanyadahriyoh and Sadehkaronhyes shall sit on one side of the council fire and their nephew Dehkaehyonh shall sit on the opposite side.

" On one side of the council fire shall then be seated Hayonhwatha, Skanyadahriyoh and Sadehkaronhyes and on the opposite side shall sit Ohdahtshedeh and Dehkaehyonh and it shall be that we shall place Thadodahho in the center between the two sets of lords in the council.

We shall establish this relationship as follows: You, Thadodahho, shall be the father of Ohdahtshedeh and Dehkaehyonh and Hahyonhwatha, Skanyadahriyoh and Sadehkaronhyes shall be your brothers and you shall be the principals of the confederation which we have just made and completed.

"The first matter which I shall lay before you for your consideration is that as clans [1] are already established among the people, that the several clans form relations as brothers and cousins.

So the lords answered and said: "We have decided to adopt your suggestion."

Then he, Dekanahwideh said: "You, Hahyonhwatha, shall be the first to come and appoint your colleagues; you are of the Turtle Clan and shall therefore appoint your colleagues of the same clan."

Then when this was done Hahyonhwatha said: "This is now all ready, they have accepted and they are as follows: De-ha-rih-ho-ken, Sa-de-ka-rih-wa-deh."

Then Dekanahwideh said: "These shall therefore be your brother colleagues, you of the Turtle Clan. The brethern of the Wolf Clan shall be Sa-renh-ho-wa-neh,[2] De-yon-heh-kon [3] and On-renh-reh-ko-wah [4] and our cousins of the Bear Clan [5] shall be De-hen-nah-ke-re-neh,[6] Ah-stah-weh-seh-ron-ron-tha [7] and Soh-skȯ-ha-roh-wa-neh." [8]

Then Dekanahwideh said: "You, Hahyonhwatha, have now completed appointing your colleagues of your nation, as the Good Tidings of Peace and Power first originated at Kan-yen-geh, you shall be called Ka-nyen-geh-ha-kah [9] (Mohawk)."

Then Dekanahwideh said to Hahyonhwatha: "Now it shall fall upon your son Ohdahtshedeh who sits upon the opposite side of the council fire to appoint his brother colleagues." Then Ohdahtshedeh appointed his brother colleagues of the Turtle Clan as follows: So-non-sehs [10] (Long House), Tho-nahonh-ken-ah [11] and A-tye-donj-eneh-tha.[12] And then he, Ta-na-o-ge-a, appointed his cousins of the Bear Clan as follows: Deh-ha-da-weh-de-yons,[13] Deh-ha-nyen-da-sah-deh [14] and Roh-wa-tsha-don-hon.[15]. These being the

[1] In some traditions the origin of the clans is stated as coeval with the beginning of the Confederacy; the more accurate view is that clans had long existed.

[2] Saihowa′ne.

[3] Dionhekwi.

[4] Orhehe″gowa.

[5] Hodigwaho″.

[6] Dehenagai′ne‘, Dragging horns.

[7] Hastamĕ’sĕ^{n}tă’, Dropped rattle.

[8] Soskohai′ine‘.

[9] Kanyĕ^{n}gĕhā′kă, Flint people; cf. kanyeñgĕ’, flinty place.

[10] Sono″s‘es.

[11] Tonaoge^{n}″ā.

[12] Hadyă’donent′ha, Swallows his own body.

[13] Dehadaho^{n}dĕ^{n}yonk.

[14] Dehanye’dāsäyeñ’, Two legs together.

[15] Howashado^{n}onkho‘.

second nation who accepted the message of Peace and Power and as their settlement (from whence they came) was where the great historic stone was situated, O-neh-yont, they were called O-neh-yo-deh-ha-ka.[1] (Oneidas).

Then Dekanahwideh said: "It shall now rest with you, the uncles, Skanyadahriyoh and Sadehkaronhyes, to appoint your colleagues." Then Skanyadahriyoh said: "I (myself) shall appoint two of my brothers and my cousin, Sa-deh-ka-ronh-yes, shall appoint two of his brethern." Then Skanyadahriyoh of the Turtle Clan also said: "I therefore now appoint Ka-no-kye [2] of the Turtle Clan and Sa-tye-na-wat [3] of the Bear Clan as my colleagues."

Then Sa-deh-ka-ronh-yes of the Snipe clan said: "I now appoint Sa-ken-jo-wah-neh [4] of the Pigeon Hawk Clan and Nis-ha-yeh-nehs [5] of the Snipe Clan as my colleagues."

Then Dekanahwideh said: "You have all appointed your colleagues and Kanokye [6] and Sakenhiwahneh [7] shall be cousins, and Nishayehnehs and Satyenawat [8] shall be cousins." He then said, "You, Skanyadahriyoh and Sadehkaronhyes of the Seneca Nation, have now completed appointing your colleagues. Your settlement is at the big mountain and you shall therefore be called O-neh-do-wah-ka [9] (people of the big mountain) Senecas."

Then Dekanahwideh also said: "And now your son Deh-ka-eh-yonh,[10] who sits on the opposite side of the council fire, shall name and appoint his colleagues."

Then Dehkaehyonh of the Big Bear Clan appointed his colleagues, saying as follows: "I shall now appoint my son Ji-non-dah-weh-honh [11] of the Ball Clan and my mother Ka-da-gwa-seh [12] of the Bear Clan and my brother Sho-yonh-wehs [13] of the Young Bear Clan and Hathatrohneh [14] of the Turtle Clan, Dyon-yonh-koh [15] of the Hand Clan, and Deh-yoh-doh-weh-kon [16] of the Wolf Clan, and

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1 Onäyont, or Hadiniyutgă".
2 Ga'no^{n}găĭ'.
3 Sadyĕ'nawat.
4 Sagendjo'nă.
5 Nishayene''thă'.
6 Ga'no^{n}gă-ĭ'.
7 Gakĕ^{n}iwanĕ'.
8 Sadyē'nawat.
9 Onundawāga, Nundawā'g'g, The hill people.
10 De'hagă'e^{n}yok.
11 Djinon'dăwē'ho^{n}.
12 Kadăgwā'dji.
13 Sho'yoñwēs, Long wind.
14 Ha-tha"troh-ne'.
15 Dion'yoñko'.
16 Diotowĕ"kon, Two colds.

Dyon-weh-thoh[1] of the Snipe Clan. These are the brother colleagues.

Then Deh-ka-eh-yonh appointed the cousin of the chief so named as follows: Nah-don-dah-heh-ha[2] of the Plover Clan and Des-da-heh[3] of the Young Bear Clan.

Then Dekanahwideh said: "You, Deh-ka-eh-yonh[4] of the Cayuga Nation, have now finished appointing your colleagues and you shall therefore be called Queh-you-gwe-hah-ka[5] (Cayuga) from your custom of portaging your canoe at a certain point in your settlement."

Then Dekanahwideh also said: "I shall now leave it to you, Tha-do-dah-ho, to appoint your colleagues."

Then Thadodahho of the Bear Clan said: "The first I shall appoint will be Onh-neh-sah-heh,[6] my cousin of the Beaver Clan, and Ska-nya-da-ge-wak[7] of the Snipe Clan and Ah-weh-ken-yath[8] of the Ball Clan and Deh-ha-yat-kwa-eh[9] of the Turtle Clan, and these are all brothers."

Then Thadodahho appointed their son, Ho-noh-we-yeh-deh[10] of the Wolf Clan, and then Thadodahho appointed his (Ho-noh-we-yeh-dehs) uncles as follows: Kon-weh-neh-senh-don of the Deer Clan and Ha-he-honk also of the Deer Clan and then their brothers as follows: Ho-yonh-nye-neh[11] of the Eel Clan and So-deh-kwa-seh[12] also of the Eel Clan and Sa-ko-ken-o-heh[13] of the Pigeon Hawk Clan, and then he (Thadodahha) appointed the sons of the latter as follows: Ho-sah-ha-wa[14] of the Deer Clan and Ska-nah-o-wa-da[15] of the Small Turtle Clan.

Then Dekanahwideh spoke and said: "We have now come to appointing the lords of the Five Nations hereby represented. These lords have now all been crowned with deer's horns in conformity and in a similar manner to Thadodahho who was first crowned. Therefore we have now accomplished and completed the work of laying the foundation of the confederation."

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1 Dionwăthon^{n}".
2 Nadondahē′hă'.
3 Desgā′hĕ'.
4 De'hagă'e^{n}yok.
5 Gwīio"gwehā′ka, drawn up from the water people.
6 Oni'säähä'.
7 Skanyă'dadji′wak, Bitter throat.
8 Aweke^{n}"yat, Near the shore.
9 Dehayatgwa′īĕ^{n}. Red spots on wings.
10 Honowiyĕ"ghī.
11 Hoyo^{n}nyĕ^{n}"ni'.
12 Sodĕ'gwāsĕ^{n}', Bruised all over.
13 Sāgogĕ^{n}"hē', I shall see them again.
14 Hosähāhwi.
15 Skanawā′di.

PACIFICATION OF THE SENECA CHIEFS

Then Dekanahwideh spoke again and said: "I will now lay before your confederate council for your consideration one matter, and that is with reference to the conduct of the chief warriors of O-non-do-wa-ka (Senecas) who have refused to act in conjunction (or accord) with the lords in accepting the message of Good Tidings of Peace and Power."

Then the lords sent messengers for these two chief warriors of the Onondowaka (Senecas) to appear. And when they had come to the council, Lord Hahyonhwatha addressed these two chief warriors and said: "This Confederate Council now in session, together with their warriors, have unanimously accepted the message of Peace and Power and only you two chief warriors have not yet accepted and neither have expressed yourselves on this matter." Then Hayonhwatha further said: "This Confederate Council and their chief warriors have unanimously decided to leave all the war power and military control of the people in your hands providing you accept the message so that in case of war with other nations you shall be the leaders of the people of the Confederate Nations in defense of their confederacy." Then one of these two warriors spoke and said: "We are agreed to accept the message."

Then Dekanahwideh continued his address and said: "Now our power is full and complete and the two chief warriors of the Onondowaka (Senecas) have agreed to accept the message of Good Tidings; therefore we shall now add to the number of the lords of the confederacy (Eh-ji-twa-nah-stah-soh-de-renh),[1] we shall call it Ka-na-stah-ge-ko-wah[2] and these two chief warriors shall represent the door of the long house. Ka-noh-hah-ge-ko-wah,[3] meaning *the great black door through which all good and evil messages must come to reach the confederate house of lords or council,* shall be the name of the door, and if any person or nation has any news, message or business matter to lay before the Confederate Council, he or they must come through this door."

Then Dekanahwideh again further said, "We shall now crown these two chief warriors with deer's horns[4] and make them lords also. We shall now first crown with deer's horns Deyohneohkaweh[5] of the Wolf Clan and then we shall also crown Kanonkedahwe[6]

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[1] Nedjitwanastashoñdä‘.
[2] Kana'stadjigo'wa, Black timbers.
[3] Kanohwa'gēgo'na.
[4] Skänoⁿdoⁿonă'’gā, Deer horns.
[5] Deyoñeñhogă'’wĕ‘, Open door.
[6] Kanoⁿ'gida'hwĭ', Hair burned off.

Plate 5

Reciting the Laws of the Confederacy

From an engraving in Lafitau's, Moeurs des Sauvages Ameriquains, published in 1724

of the Snipe Clan and these two shall be cousins and they shall guard the door of the long house.[1] And we shall now floor the doorway with slippery elm bark, and it shall be that whenever we have visitors from other nations who will have any message or any business to lay before the Confederate Council, these two door-keepers shall escort and convey them before the council, but whenever the visitor or visitors have come for evil purposes, then Kanonkedahwe shall take them by the hand and lead them in and they shall slip on the slippery elm bark and fall down and they shall be reduced to a heap of bones (He-yoh-so-jo-de-hah [2] in Onondaga language; Ehyohdonyohdaneh in Mohawk), and the bones of the enemy shall fall into a heap before the lords of the confederacy." (A heap of bones here signifies a conquered nation to be dealt with by the lords of the confederacy who shall decide as to what manner they will be allowed to exist in the future.)

LAWS OF THE CONFEDERACY

Then Dekanahwideh again said: "We have completed the Confederation of the Five Nations, now therefore it shall be that hereafter the lords who shall be appointed in the future to fill vacancies caused by death or removals shall be appointed from the same families and clans from which the first lords were created, and from which families the hereditary title of lordships shall descend."

Then Dekanahwideh further said: "I now transfer and set over to the women who have the lordships' title vested in them, that they shall in the future have the power to appoint the successors from time to time to fill vacancies caused by death or removals from whatever cause."

Then Dekanahwideh continued and said: "We shall now build a confederate council fire [3] from which the smoke shall arise and pierce the skies and all nations and people shall see this smoke. And now to you, Thadodahho, your brother and cousin colleagues shall be left the care and protection of the confederate council fire, by the Confederate Nations."

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[2] The term "long house" as applied to the confederacy is not generally used by the Canadian Iroquois in their manuscript copies of the confederate laws and legends. A mistaken notion that the long house idea originated with Handsome Lake accounts for it. Newhouse used the term "long house" in his earlier manuscripts but later erased it supplying the word "confederacy." He explained this by saying that he had heard an old man say that long house meant Handsome Lake's new religion, the thing that destroyed the knowledge of the old ways. Thus the term was tabooed in connection with the confederacy.

[2] E^{n}'yosodjodä''ha.

[3] Gadjista'iĕ^{n}'.

Then Dekanahwideh further said: "The lords have unanimously decided to spread before you on the ground this great white wampum belt Ska-no-dah-ken-rah-ko-wah[1] and Ka-yah-ne-renh-ko-wah,[2] which respectfully signify purity and great peace, and the lords have also laid before you this great wing, Ska-weh-yeh-seh-ko-wah,[3] and whenever any dust or stain of any description falls upon the great belt of white wampum, then you shall take this great wing and sweep it clean." (Dust or stain means evil of any description which might have a tendency to cause trouble in the Confederate Council.)

Then Dekanahwideh said: "The lords of this confederacy have unanimously decided to lay by you this rod (Ska-nah-ka-res)[4] and whenever you see any creeping thing which might have a tendency to harm our grandchildren or see a thing creeping toward the great white wampum belt (meaning the Great Peace), then you shall take this rod and pry it away with it, and if you and your colleagues fail to pry the creeping, evil thing out, you shall then call out loudly that all the Confederate Nations may hear and they will come immediately to your assistance."

Then Dekanahwideh said: "Now you, the lords of the several Confederate Nations, shall divide yourselves and sit on opposite sides of the council fire as follows: "You and your brother colleagues shall sit on one side of the council fire (this was said to the Mohawks and the Senecas), and your sons, the Oneidas and Cayugas, shall sit on the opposite side of the council fire. Thus you will begin to work and carry out the principles of the Great Peace (Ka-yah-ne-renh-ko-wah) and you will be guided in this by the great white wampum belt (Ska-no-dah-ke-rah-ko-wah) which signifies Great Peace."

Then Dekanahwideh said: "You, Thadodahho, shall be the fire keeper, and your duty shall be to open the Confederate Council with praise and thanksgiving to the Great Ruler and close the same."

Then Dekanahwideh also said: "When the council is opened, Hayonhwatha and his colleagues shall be the first to consider and give their opinion upon any subject which may come before the council for consideration, and when they have arrived at a decision, then shall they transfer the matter to their brethren, the Senecas, for their consideration, and when they, the Senecas, shall have

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[1] Skanoⁿ'dă'kerhagona.
[2] Gayanässhägona (Onon.).
[3] Another belt known as the great wing, Dega'yadoⁿwa'ne (Onon.).
[4] Ganagā'is.

arrived at a decision on the matter then they shall refer it back to Hahyonhwatha and his colleagues. Then Hahyonhwatha will announce the decision to the opposite side of the council fire.

"Then Ohdahtshedeh and his colleagues will consider the matter in question and when they have arrived at a decision they will refer the matter to their brethren, the Cayugas, for their consideration and after they have arrived at a decision, they will refer the matter back to Ohdahtshedeh and his colleagues. Then Ohdahtshedeh will announce their decision to the opposite side of the council fire. Then Hahyonhwatha will refer the matter to Thadodahho and his colleagues for their careful consideration and opinion of the matter in question and if Thadodahho and his colleagues find that the matter has not been well considered or decided, then they shall refer the matter back again to the two sides of the council fire, and they shall point out where, in their estimation, the decision was faulty and the question not fully considered, and then the two sides of the council will take up the question again and reconsider the matter, and after the two sides of the council have fully reconsidered the question, then Hahyonhwatha will again refer it to Thadohahho and his colleagues, then they will again consider the matter and if they see that the decision of the two sides of the council is correct, then Thadodahho and his colleagues will confirm the decision."

Then Dekanahwideh further said: "If the brethren of the Mohawks and the Senecas are divided in their opinion and can not agree on any matter which they may have for their consideration, then Hahyonhwatha shall announce the two decisions to the opposite of the council fire. Then Ohdahtshedeh and his brother colleagues, after they have considered the matter, and if they also are divided in their decision, shall so report, but if the divided factions each agree with the decision announced from the opposite side of the council, then Ohdahtshedeh shall also announce their two decisions to the other side of the council fire; then Hahyonhwatha shall refer the matter to Thadodahho and his colleagues who are the fire keepers. They will fully consider the matter and whichever decision they consider correct they will confirm."

Then Dekanahwideh said: "If it should so happen that the lords of the Mohawks and the lords of the Senecas disagree on any matter and also on the opposite side of the council fire, the lords of the Oneidas and the lords of the Cayugas disagree among themselves and do not agree with either of the two decisions of the

opposite side of the council fire but of themselves give two decisions which are diverse from each other, then Hahyonhwatha shall refer the four decisions to Thadodahho and his colleagues who shall consider the matter and give their decision and their decision shall be final."

Then Dekanahwideh said: "We have now completed the system for our Confederate Council."

Then Dekanahwideh further said: "We now, each nation, shall adopt all the rules and regulations governing the Confederate Council which we have here made and we shall apply them to all our respective settlements and thereby we shall carry out the principles set forth in the message of Good Tidings of Peace and Power, and in dealing with the affairs of our people of the various dominions, thus we shall secure to them contentment and happiness."

Then he, Dekanahwideh, said: "You, Ka-nyen-ke-ha-ka (Mohawk), you, Dekarihoken, Hahyonhwatha and Sadekarihwadeh, you shall sit in the middle between your brother lords of the Mohawks, and your cousin lords of the Mohawks, and all matters under discussion shall be referred to you by your brother lords and your cousin lords for your approval or disapproval.

"You, O-nen-do-wa-ka (Senecas), you, Skanyhadahriyoh and Sadeh-ka-ronh-yes, you shall sit in the middle or between your brother lords and your cousin lords of the Senecas and all matters under discussion shall be referred to you by them for your approval or disapproval.

"You, Ohnenyohdehaka (Oneidas), you, Ohdahtshedeh, Kanonkweyoudoh and Deyouhahkwedeh, you shall sit in the middle between your brother lords and your cousin lords of the Oneidas and all matters under discussion shall be referred to you by them for your approval or disapproval.

"You, the Que-yenh-kwe-ha-ka (Cayugas), you, Dekaehyonh and Jinondahwehonh, you shall sit in the middle between your lords and your cousin lords of the Cayugas and all matters under discussion shall be referred to you by them for your approval or disapproval."

Then Dekanahwideh said: "We have now completed arranging the system of our local councils and we shall hold our annual Confederate Council at the settlement of Thadodahho, the capitol or seat of government of the Five Nations' Confederacy."

Dekanahwideh said: "Now I and you lords of the Confederate Nations shall plant a tree Ska-renj-heh-se-go-wah[1] (meaning a tall

[1] Skarhehē"gowa.

and mighty tree) and we shall call it Jo-ne-rak-deh-ke-wah [1] (the tree of the great long leaves).

"Now this tree which we have planted shall shoot forth four great, long, white roots (Jo-doh-ra-ken-rah-ko-wah).[2] These great, long, white roots shall shoot forth one to the north and one to the south and one to the east and one to the west, and we shall place on the top of it Oh-don-yonh [3] (an eagle) which has great power of long vision, and we shall transact all our business beneath the shade of this great tree. The meaning of planting this great tree, Skarehhehsegowah, is to symbolize Ka-yah-ne-renh-ko-wa, which means Great Peace, and Jo-deh-ra-ken-rah-ke-wah, meaning Good Tidings of Peace and Power. The nations of the earth shall see it and shall accept and follow the roots and shall follow them to the tree and when they arrive here you shall receive them and shall seat them in the midst of your confederacy. The object of placing an eagle, Skadji′enă', on the top of the great, tall tree is that it may watch the roots which extend to the north and to the south and to the east and to the west, and whose duty shall be to discover if any evil is approaching your confederacy, and he shall scream loudly and give the alarm and all the nations of the confederacy at once shall heed the alarm and come to the rescue."

Then Dekanahwideh again said: "We shall now combine our individual power into one great power which is this confederacy and we shall therefore symbolize the union of these powers by each nation contributing one arrow, which we shall tie up together in a bundle which, when it is made and completely tied together, no one can bend or break."

Then Dekanahwideh further said: "We have now completed this union by securing one arrow from each nation. It is not good that one should be lacking or taken from the bundle, for it would weaken our power and it would be still worse if two arrows were taken from the bundle. And if three arrows were taken any one could break the remaining arrows in the bundle."

Then Dekanahwideh continued his address and said: "We shall tie this bundle of arrows together with deer sinew which is strong, durable and lasting and then also this institution shall be strong and unchangeable. This bundle of arrows signifies that all the lords and all the warriors and all the women of the Confederacy have become united as one person."

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[1] Onä″dedjisko′na skaskohāi′nă', Big long leaves, big limber tree.
[2] Djok'dehēsgo′na.
[3] The "upper world eagle" is called skadji′ēnă'.

Then Dekanahwideh again said: "We have now completed binding this bundle of arrows and we shall leave it beside the great tree (Skarehhehsegowah) and beside the Confederate Council fire of Thadodahho."

Then Dekanahwideh said: "We have now completed our power so that we the Five Nations' Confederacy shall in the future have one body, one head and one heart."

Then he (Dekanahwideh) further said: "If any evil should befall us in the future, we shall stand or fall united as one man."

Then Dekanahwideh said: "You lords shall be symbolized as trees of the Five Confederate Nations. We therefore bind ourselves together by taking hold of each other's hands firmly and forming a circle so strong that if a tree shall fall prostrate upon it, it could neither shake nor break it, and thus our people and our grandchildren shall remain in the circle in security, peace and happiness. And if any lord who is crowned with the emblem of deer's horns shall break through this circle of unity, his horns shall become fastened in the circle, and if he persists after warning from the chief matron, he shall go through it without his horns and the horns shall remain in the circle, and when he has passed through the circle, he shall no longer be lord, but shall be as an ordinary warrior and shall not be further qualified to fill any office."

Then Dekanahwideh further said: "We have now completed everything in connection with the matter of Peace and Power, and it remains only for us to consider and adopt some measure as to what we shall do with reference to the disposal of the weapons of war which we have taken from our people."

Then the lords considered the latter and decided that the best way which they could adopt with reference to the disposal of the weapons would be to uproot the great tall tree which they had planted and in uprooting the tree a chasm would form so deep that it would come or reach the swift current of the waters under it, into which the weapons of war would be thrown, and they would be borne and swept away forever by the current so that their grandchildren would never see them again. And they then uprooted the great tree and they cast into the chasm all manner of weapons of war which their people had been in the custom of using, and they then replaced the tree in its original position.

Then Dekanahwideh further continued and said: "We have completed clearing away all manner of weapons from the paths of our people."

Then Dekanahwideh continued and said: "We have still one matter left to be considered and that is with reference to the hunting grounds of our people from which they derive their living."

They, the lords, said with reference to this matter: "We shall now do this: We shall only have one dish (or bowl) in which will be placed one beaver's tail and we shall all have coequal right to it, and there shall be no knife in it, for if there be a knife in it, there would be danger that it might cut some one and blood would thereby be shed." (This one dish or bowl signifies that they will make their hunting grounds one common tract and all have a coequal right to hunt within it.[1] The knife being prohibited from being placed into the dish or bowl signifies that all danger would be removed from shedding blood by the people of these different nations of the confederacy caused by differences of the right of the hunting grounds.)

Then Dekanahwideh continued and said: "We have now accomplished and completed forming the great Confederacy of the Five Nations together with adopting rules and regulations in connection therewith."

Then he, Dekanahwideh, continued and said: "I will now leave all matters in the hands of your lords and you are to work and carry out the principles of all that I have just laid before you for the welfare of your people and others, and I now place the power in your hands and to add to the rules and regulations whenever necessary and I now charge each of you lords that you must never seriously disagree among yourselves. You are all of equal standing and of equal power, and if you seriously disagree the consequences will be most serious and this disagreement will cause you to disregard each other, and while you are quarreling with each other, the white panther[2] (the fire dragon of discord)[3] will come and take your rights and privileges away. Then your grandchildren will suffer and be reduced to poverty and disgrace."

Then he, Dekanahwideh, continued and said: "If this should ever occur, whoever can climb a great tree (Skarehhehsegowah) and ascend to the top, may look around over the landscape and will see if there is any way or place to escape to from the calamity of the threatening poverty and disgrace, so that our children may have a home where they may have peace and happiness in their day.

[1] Dio^{n}dowĕs'tă', hunting ground.
[2] Usually translated *lion*.
[3] Oshondowĕk'gona.

And if it so occurs that he can not see any way or place to escape the calamity, he will then descend the tree. You will then look for a great swamp elm tree (Aka-rah-ji-ko-wah) [1] and when you have found one with great large roots extending outwards and bracing outwards from the trunk, there you will gather your heads together."

Then Dekanahwideh continued and said: "It will be hard and your grandchildren will suffer hardship. And if it may so occur that the heads of the people of the confederacy shall roll and wander away westward, if such thing should come to pass, other nations shall see your heads rolling and wandering away and they shall say to you, 'You belong to the confederacy, you were a proud and haughty people once,' and they shall kick the heads with scorn, and they shall go on their way, but before they shall have gone far they shall vomit up blood." (Meaning that the confederacy shall still have power enough to avenge their people.)

Then Dekanahwideh further said: "There may be another serious trouble. Other nations may cut or hack these four great roots which grow from the great tree which we have planted and one of the roots shoots to the north and one to the south and one to the east and one to the west. Whenever such thing happens, then shall great trouble come into the seat of your lords of the confederacy."

Then Dekanahwideh said: "I shall now therefore charge each of your lords, that your skin be of the thickness of seven spreads of the hands [2] (from end of thumb to the end of the great finger) so that no matter how sharp a cutting instrument may be used it will not penetrate the thickness of your skin. (The meaning of the great thickness of your skins is patience and forbearance, so that no matter what nature of question or business may come before you, no matter how sharp or aggravating it may be, it will not penetrate to your skins, but you will forbear with great patience and good will in all your deliberations and never disgrace yourselves by becoming angry.) You lords shall always be guided in all your councils and deliberations by the Good Tidings of Peace and Power."

Then Dekanahwideh said: "Now, you lords of the different nations of the confederacy, I charge you to cultivate the good feeling of friendship, love and honor amongst yourselves. I have now

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[1] Gain′dadjikgo′na.
[2] Djadŭk′nioyionk′gage′, seven fingers.

Plate 6

Council pipe used in the ceremonies of raising a civil chief. This pipe was last owned by Albert Cusick, who presented it to the State Museum in 1911.

fulfilled my duty in assisting you in the establishment and organization of this great confederacy, and if this confederation is carefully guarded it shall continue and endure from generation to generation and as long as the sun shines. I shall now, therefore, go home, conceal and cover myself with bark and there shall none other be called by my name."

Then Dekanahwideh further continued and said: "If at any time through the negligence and carelessness of the lords, they fail to carry out the principles of the Good Tidings of Peace and Power and the rules and regulations of the confederacy and the people are reduced to poverty and great suffering, I will return."

Then Dekanahwideh said: "And it shall so happen that when you hear my name mentioned disrespectfully without reason or just cause, but spoken in levity, you shall then know that you are on the verge of trouble and sorrow. And it shall be that the only time when it shall be proper for my name to be mentioned is when the condolence ceremonies are being performed or when the Good Tidings of Peace and Power which I have established and organized are being discussed or rehearsed."

Then the lords (Ro-de-ya-ner-shoh) said: "We shall begin to work and carry out the instructions which you, Dekanahwideh, have laid before us."

Then they said: "We shall therefore begin first with the Confederate Council of the Five Nations and other nations who shall accept and come under the Great Law of the confederacy will become as props, supports of the long house.

"The pure white wampum strings shall be the token or emblem of the council fire, and it shall be that when the fire keepers shall open the council, he shall pick up this string of wampum and hold it on his hand while he is offering thanksgiving to the Great Ruler and opening the council." And then they also said: "That while the council is in session the strings of the white wampum should be placed conspicuously in their midst and when they should adjourn then, the fire keepers should pick up these strings of wampum again, offer thanksgiving, close the council and all business in connection with the council should then be adjourned."

Then they said: "We shall now establish as a custom that when our annual Confederate Council shall meet we shall smoke the pipe of peace."[1]

[1] Swĕ^{n}no''ändwahĕ'^{n}'.

And they, the lords, then said: " We shall now proceed to define the obligations and position of the lords of the Confederacy as follows:

" If a lord is found guilty of wilful murder, he shall be deposed without the warning (as shall be provided for later on) by the lords of the confederacy, and his horns (emblem of power) shall be handed back to the chief matron of his family and clan.

" If a lord is guilty of rape he shall be deposed without the usual warning by the lords of the confederacy, and his horns (the emblem of power) shall be handed back to the chief matron of his family and clan.

" If a lord is found guilty of theft, he shall be deposed without the usual warning by the lords of the confederacy and his horns (the emblem of power) shall be handed back to the chief matron of his family and clan.

" If a lord is guilty of unwarrantably opposing the object of decisions of the council and in that his own erroneous will in these matters be carried out, he shall be approached and admonished by the chief matron of his family and clan to desist from such evil practices and she shall urge him to come back and act in harmony with his brother lords.

" If the lord refuses to comply with the request of the chief matron of his family and clan and still persists in his evil practices of unwarrantably opposing his brother lords, then a warrior of his family and clan will also approach him and admonish him to desist from pursuing his evil course.

" If the lord still refuses to listen and obey, then the chief matron and warrior shall go together to the warrior and they shall inform him that they have admonished their lord and he refused to obey. Then the chief warrior will arise and go there to the lord and will say to him: ' Your nephew and niece have admonished you to desist from your evil course, and you have refused to obey.' Then the chief warrior will say: ' I will now admonish you for the last time and if you continue to resist, refuse to accede and disobey this request, then your duties as lord of our family and clan will cease, and I shall take the deer's horns from off your head, and with a broad edged stone axe I shall cut down the tree' (meaning that he shall be deposed from his position as lord or chief of the confederacy). Then, if the lord merits dismissal, the chief warrior shall hand back the deer's horns (the emblem of power) of the deposed lord to the chief matron of the family or clan."

Whenever it occurs that a lord is thus deposed, then the chief matron shall select and appoint another warrior of her family or clan and crown him with the deer's horns and thus a new lord shall be created in the place of the one deposed.

The lords of each of the confederate nations shall have one assistant and their duty, each of them, shall be to carry messages through the forests between our settlements and also in the absence of the lord through illness or any other impediment he shall be deputed by him (his lord) to act in his place in council.

The lords then said: "We have now completed defining the obligations and positions of a lord (Royaner) and therefore in accordance with the custom which we now have established, it shall be that when a lord is deposed and the deer's horns (emblem of power) are taken from him, he shall no longer be allowed to sit in council or even hold an office again."

Then the lords continued and said: "What shall we do in case some of us lords are removed by sudden death and in whom so much dependence is placed?"

"In such case (this shall be done), the chief matron and the warriors of the family and clan of the deceased lord, shall nominate another lord from the warriors of the family and clan of the dead lord to succeed him, then the matter will be submitted to the brother lords and if they (the brother lords) confirm the nomination, then the matter will be further submitted to their cousin lords and if they also confirm the nomination, then the candidate shall be qualified to be raised by the condolence ceremony (Honda nas)."

Then the lords continued and said: "In case the family and clan in which a lordship title[1] is vested shall become extinct, this shall be done: It shall then be transferred and vested in the hands of the confederate lords and they will consider the matter and nominate and appoint[2] a successor from any family of the brother lords of the deceased lord, and the lords may in their discretion vest the said lordship title in some family, and such title will remain in that family so long as the lords are satisfied.

"If ever it should occur that the chief matron in a family or clan in which a lordship title is vested should be removed by death and leave female infants who, owing to their infancy can not nominate a candidate to bear their lordship title, then the lords (of the same nation) at their pleasure may appoint an adult female of a sister family who shall make a temporary appointment, shall

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[1] Nihosĕnnodĕ', *the title*.
[2] The term is Naho^{n}yawădăgă yā'dĕ^{n}.

come before the lords and request that the lordship title be restored to them, then the lords must obtain the title and restore it accordingly."

Then the lords continued and said: "We now have completed laying the foundation of our rules and methods (Kayanehrenokowa) and we will now proceed to follow and carry out the working of these rules and methods of the confederacy, and the local affairs of our respective settlements, and whenever we discover a warrior who is wise and trustworthy and who will render his services for the benefit of the people and thus aid the lords of the confederacy, we will claim him into our midst and confer upon him the title of 'He has sprung up as a Pine Tree [1]' (Eh-ka-neh-do-deh) and his title shall only last during his lifetime[2] and shall not be hereditary and at his death it shall die with him."

Then the lords (Rodiyaner) again considered and said: "We have now completed the appointment of our lords. It may so occur that before we may be quietly reseated in our respective places, we may sustain another loss by death (of a lord) and in that case we shall do this: While yet the dying lord is suffering in the agonies of death, his brother lords will come and remove his deer's horns from his head and place them beside the wall and if by the will of the Great Ruler he recovers from his illness, he shall then reclaim his crown of deer's horns and resume the duties of a lord. They further considered this matter and said: "While the lord is ill we will place a string of black wampum at the head of his bed and if he dies anyone belonging to his clan may take this string of black wampum and announce his death to the whole circle of the confederacy as follows:

"If a Lord among the three brothers,[3] Mohawk, Seneca and Onondaga, dies, the chief warrior or a warrior will convey the string of black wampum to their son, Ohdahtshedeh or Dehkaehyonh, or their colleagues, and he will leave it there, and while on his way from the home of the dead lord he will repeat at regular intervals the mourning cry, three times thus—'Kwa – – – ah; Kwa – – – ah; Kwa – – – ah.'

"Then Ohdahtshedeh or Dehkaehyonh or their colleagues will convey the string of black wampum to their four brothers, and so

[1] Waganeda'nyŭk.
[2] E^{n}kanedode^{n}, *the pine tree shall grow.*
[3] A'sĕ'nihoñdadĕ^{n}"gĕ^{n}, three brothers.

on until the whole circle of the confederacy shall become aware of the death of the lord. And if a lord among the two (now four) brothers (the Oneida and Cayuga) dies, then the chief warrior or any warrior deputed will carry and convey the string of black wampum to Dekarihoken or Skanyadahriyoh or Thadodahho, or their brother colleagues, and the chief warrior or any warrior so deputed will, while on his way, repeat the mourning cry three times at regular intervals as follows: 'Kwa – – –ah; Kwa – – – ah; Kwa – – – ah;'[1] and if a chief warrior on either side of the council dies (or now if a chief of Tuscarora, Delaware, Nanticoke or Tuteli member[2] of the council dies), then the mourning messenger will, while on his way to announce the death of either of these, repeat the mourning cry twice only as follows: 'Kwa – – – ah; Kwa – – – ah.' In case of the sudden death of a lord, then his colleagues will remove his crown of deer's horns and will put it to one side where the chief matron of the family or clan to which he belonged will find and take it up again.

"If from whatever cause the crown of deer's horns are not removed from the head of the lord at the time of his death, then his colleagues will remove the same at the time of his burial and will place it beside the grave where the chief matron will find and pick it up again."

Then the lords said: "If a lord dies we will do this: we will put up a pole horizontally, and we will hang a pouch upon it, and we will put into the pouch a short string of wampum, and the side of the council fire which has sustained the loss by death shall do it and the side which has not sustained the loss will depute one of their lords to take the pouch off the pole, then he shall follow the path and go to the opposite side of the council fire where the loss has been sustained, and when he arrives at the house where the lord died he will stand at one end of the hearth and he will speak consoling words to the bereaved, and he will cheer them up, and this will be our mode of condolence, and these shall consist of eleven passages to be expressed in this condolence (Ka-ne-kon-kets-kwa-se-rah)[3] and eleven wampum strings shall be used in this ceremony.

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[1] Kwa ă″.

[2] Captive or adopted tribes having a seat and a voice in their own national affairs but no voice in the confederate council.

[3] Ganigohagetc′gwĕⁿ', Their spirits are lifted up.

THE CONDOLENCE CEREMONY

The beginning of the condolence ceremony used immediately after the death of a chief (or lord) and which is subsequently followed by the preliminary ceremony called, "At the wood's edge."

1 Now hear us our uncles, we have come to condole with you in your great bereavement.

We have now met in dark sorrow to lament together over the death of our brother lord. For such has been your loss. We will sit together in our grief and mingle our tears together, and we four brothers will wipe off the tear from your eyes, so that for a day period you might have peace of mind. This we say and do, we four brothers.

2 Now hear us again, for when a person is in great grief caused by death, his ears are closed up and he can not hear and such is your condition now.

We will therefore remove the obstruction (grief) from your ears, so that for a day period you may have perfect hearing again. This we say and do, we four brothers.

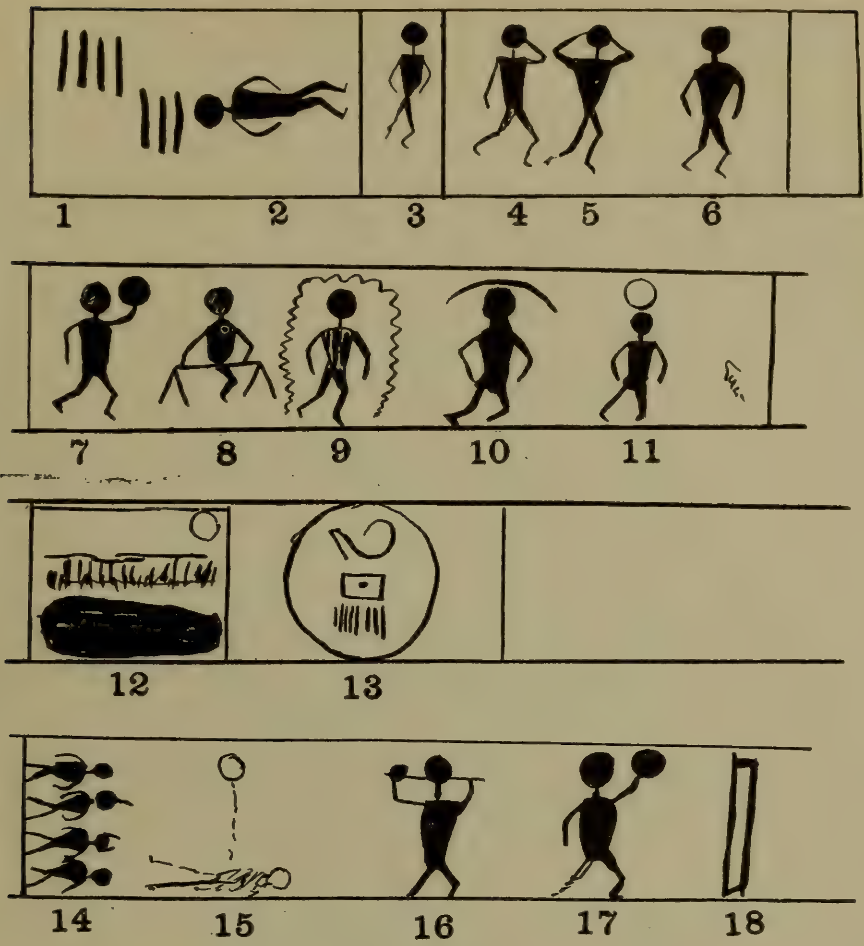
3 Continue to hear the expression of us four brothers, for when a person is in great sorrow his throat is stopped with grief and such is your case; now, we will therefore remove the obstruction (grief) so that for a day period you may enjoy perfect breathing and speech; this we say and do, we four brothers.

The foregoing part of the condolence ceremony is to be performed outside of the place of meeting.

Then the bereaved will appoint two of their chief warriors to conduct the four brothers into the place of meeting.

4 Continue to hear the expression of us four brothers, for when a person is in great grief caused by death, he appears to be deformed, so that our forefathers have made a form which their children may use in condoling with each other (Ja-wek-ka-ho-denh) which is that they will treat him a dose of soft drink (medicine) and which when it is taken and settled down in the stomach it will pervade the whole body and strengthen him and restore him to a perfect form of man. This we say and do, we four brothers.

5 Continue to hear the expression of us four brothers. Now



PICTOGRAPHS ON RECORD STAFF

(1) The seven parallel lines represent the four elder brothers and the three younger brothers of the eight clans who are mourning. (2) The prostrate figure is that of the dead chief of the eighth clan. (3) A chanter of condolence appears to comfort the sorrowing friends and relatives, (4) he lifts one hand to say, "we are mourning," (5) then both arms are raised to the heavens and he asks the people to look to the sun and be gladdened, and (6) then he points to the earth where sorrow shall be buried. (7) "Behold the sun in its brightness shining (8) for there sits the new chief (royaneh) on a bench with four legs, like the roots of the great tree." (9) Now the chief is in a bower of pine boughs where his enemies cannot discover him, there he sits and thinks of his duties. (10) Night covers him and he still meditates, (11) but the morning sun comes again like a circle of horns over his head and he approaches like the new sun. It shines over the new chief and (12) it shines over the grave of the chief who died. (13) Then shall the clans come in council and the new chief appears before them on a new mat, but the path is not yet clear or straight, until the (14) mourning clans arise and take their minds from (15) the dead chief whose spirit has gone after ten days from his body. Then (16) the new chief takes his staff and (17) goes forward with his sun before him, as a light to his mind and that people may see he is royaneh. Then (18) is his door open and his path made clear.

when a person is brought to grief by death, such person's seat or bed seems stained with human blood; such is now your case.

We therefore wipe off those stains with soft linen so that your seat and bed may be clean and so that you may enjoy peace for a day, for we may scarcely have taken our seats before we shall be surprised to hear of another death. This we say and do, we four brothers.

6 Continue to hear the expression of us four brothers. When a person is brought to grief through death, he is confined in the darkness of deep sorrow, and such is now the case of your three brothers. This we say, we four brothers.

7 When a person is brought to grief by death, he seems to lose sight of the sky (blinded with grief) and he is crushed with sorrow. We therefore remove the mist from your eyes, so that the sky may be clear to you. This we say and do, we four brothers.

8 When a person is brought to grief by death he seems to lose the sight of the sun; this is now your case. We therefore remove the mist so that you may see the sun rising over the trees or forest in the east, and watch its course and when it arrives in midsky, it will shed forth its rays around you, and you shall begin to see your duties and perform the same as usual. This we say and do, we four brothers.

9 Now when the remains are laid and cause the mound of clay (grave), we till the ground and place some nice grass over it and place a nice slab over it, so that his body (that of the dead lord) may quietly lay in his resting place, and be protected from the heavy wind and great rain storms. This we say and do, we four brothers.

10 Now continue to listen, for when a person is brought to grief, and such is your condition, the sticks of wood from your fire are scattered caused by death, so we the four brothers, will gather up the sticks of wood and rekindle the fire, and the smoke shall rise and pierce the sky, so that all the nations of the confederacy may see the smoke, and when a person is in great grief caused by the death of some of our rulers, the head is bowed down in deep sorrow. We therefore cause you to stand up again, our uncles and surround the council fire again and resume your duties. This we say and do, we four brothers.

11 Continue to listen for when the Great Spirit created us, he created a woman as the helpmate of man, and when she is called

Record staff containing the history of a condolence and raising ceremony of a royaneh or councellor.

away by death, it is grievously hard for had she been allowed to live she may have raised a family to inhabit the earth, and so we four brothers raise the woman again (to encourage and cheer up their downcast spirits) so that you may cheerfully enjoy peace and happiness for a day. This we say and do, we four brothers.

12 Now my uncle lords, you have two relations, a nephew and a niece. They are watching your course. Your niece may see that you are making a misstep and taking a course whereby your children may suffer ruin or a calamity, or it may be your nephew who will see your evil course and never bear to listen when the woman or warrior approach you and remind you of your duties, and ask you to come back and carry out your obligations as a Royaner or lord of the band. This we say and do, we four brothers.

13 They say it is hard for any one to allow his mind to be troubled too greatly with sorrow. Never allow yourself to be led to think of destroying yourself by committing suicide for all things in this world is only vanity. Now we place in your midst a torch. We all have an equal share in the said light, and would now call all the Rodhanersonh (lords) to their places and each perform the duties conferred upon each of them. This we say and do, we four brothers.

Now we return to you the wampum which we received from you when you suffered the loss by death. We will therefore now conclude our discourse. Now point out to me the man whom I am to proclaim as chief in place of the deceased.

THE HIAWATHA TRADITION

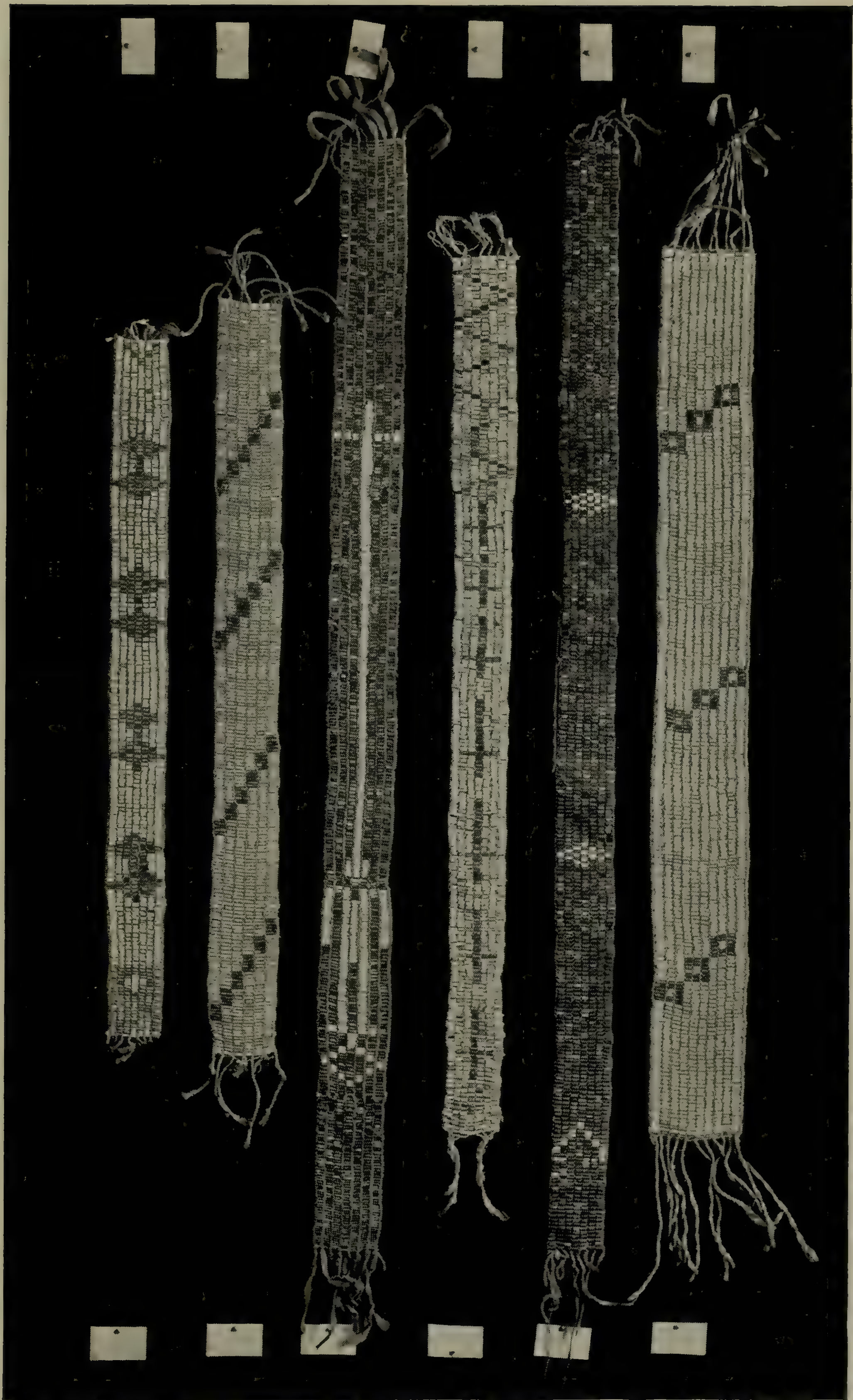
Related by Baptist Thomas (Sa ha whi) an Onondaga (Turtle Clan) as he had it from Thomas Commissary (Ostowāgō'nă* Big Feather).

When a man's heart is heavy with sorrow because of death he wanders aimlessly (wa-hē-des-yas-sha-dā'′-na').[1] That is why Ha-yĕnt-watha went away from the Mohawks. His only sister — he had only one sister — died. She was Da-si-yu' and she died. She was not a comely woman but her brother loved her and so Ha-yent-watha mourned and no one came to comfort him. Not one person came to him in his grief to comfort him, therefore his mind was clouded in darkness. His throat was dry and heavy and bitter. So he went away for he did not wish to stay among a people who had no hearts of sympathy for sorrow. The Mohawks had grown callous and so accustomed to troubled times that they did not care for the sorrows of others and even despised the tears of mourners. They were always fighting. Even they sent out war parties among their own relatives in other towns. Hayentwatha often said this was wrong but no one listened to him. So when his great sorrow came he went away. He took a canoe and went upstream. He paddled up the Mohawk river and when he landed to camp he talked to himself about his sorrow. "I would comfort others in sorrow," he said, "but no one comforts me."

After a long time he reached the portage and carried his canoe to Wood creek.[2] Here he camped three days. He took up his journey again and camped at one of two islands and went through Oneida lake. Then he went up the river and came to Three River point. Here he heard a broken branch creaking against a tree. It cried giis, giis, giis, so he named this spot Dyo-neda-tonk. So then he went up the river into Onondaga lake. He landed on the north side, (near the present site of Liverpool),[4] and built a hut. Here he made a camp fire and stayed for three days. Then he saw the monster. He was a long way off and he was looking at Hayĕnt-watha. So Hayĕntwatha moved his camp but the next morning the monster came nearer. This being was Thă-do-dā'′-ho'. So the next evening Hayĕntwatha moved his camp again and in the

[1] Onondaga vocabulary.
[2] This portage is called De-hon-yugwha-tha.
[3] Odĭ-nĕs'-shi-yū, People of the sand and they shall be of the Snipe Clan.
[4] This spot he named Gă'skwasoētge'.

Plate 7



Commemoration belts of the Five Nations recording events and alliances

morning again he saw the monster before his camp fire. It seems that he had snakes in his hair and covering his shoulders and one great one came up from his thighs and went over his shoulders. Hayĕntwatha looked at Thădodaho and said " Shon-nis' ?" (who are you?) The monstrous being did not reply but his face looked very angry.

Again Hayĕntwatha changed his camp and built a shelter on one of the two islands in the lake. This spot he named Si-ye-ge. As before, the monster camped silently near him. He was nearer than ever before and seemed watching him from the corner of his eyes.

So then again Hayĕntwatha moved his camping place. He crossed the lake and camped at the point on the south shore. As he built his lodge he looked inland and saw seated on a knoll, the monster Thădodā′ho'. He then observed that what ever move he made the snake-bearing monster was ever before him. He seemed to anticipate his movements. This fact frightened Hayĕntwatha and he prepared to take up his journey again.

His sorrow was not diminished but hung like a black cloud over him. His heart was very heavy and there was no clear sky for him. He carried no war weapons and the monster frightened him. So Hayĕntwatha journeyed in his canoe up Onondaga creek. So in this manner he came to the Onondaga village. How long he stayed at the Onondaga town, my grandfather, Tom Commissary, did not say. Some say he stayed there and married. Some say he enjoined the Onondaga towns to be at peace and stop their quarreling. After a time when another great sorrow came, some say it was because his daughters died, he again continued his journey but Thădodā′ho' went before him and Hayĕntwatha saw him.

So Hayĕntwatha went south up Onondaga creek and he came to a certain spot where a brook enters the creek[1] and he saw there a pond and a grassy place. There it is said he saw a very large turtle and some women playing ball. Some say boys were playing ball but I say that women were playing ball because my grandfather said so. So Hayĕntwatha called this place Dwĕ^{n}-the′-gă^{s}, and said from this spot comes the Ball Clan (Dwĕ^{n}-the-gă^{s} Hadinya'-tĕ$^{n\prime}$) of the Great Turtle.

Hayĕntwatha continued his journey and went over Bear mountain.[2] First he camped at night at the foot of the high hill. Here

[1] A brook running through Cardiff, N. Y.
[2] Southwest of Cardiff, Lafayette township, Onondaga county.

he built a shelter. That night he heard a song and its words were what he believed and had spoken many times to the Onondaga chiefs and to the Mohawks.

In the morning he ascended the mountain and there he found five stalks of corn springing from four roots and there was only one large stalk at the root from which the five stalks grew. On each stalk were three large ears of ripe corn. Near the corn he saw a large turtle with a red and yellow belly and it was the turtle that danced. He danced the Ostowago′na, the great feather dance. So then Hayĕntwatha said "Did you sing last night? I heard singing." Then the turtle replied, "I sang. Now this is the great corn and you will make the nations like it. Three ears represent the three nations[1] and the five stalks from a single stalk represent the five nations and the four roots go to the north and west the south and the east."

Hayĕntwatha proceeded on his journey and after a time he came to a group of lakes. He called it Tgă-ni-yä-da-hä-nioñ (the lake group on hill) (the present Tully group of lakes). On one of these lakes were many ducks swimming very closely together. The ducks covered the lake. So Hayĕntwatha stopped to look at so strange a sight. "What are you doing there, so many of you?" he said all to himself. The ducks heard him and at the same moment, whoo! every one of them flew into the air and lifted up the water, so quickly did they fly up. The bottom of the lake was left dry and Hayĕntwatha walked across it. As he walked he saw many small shells and he gathered a deer skin full of shells so many were there. When he reached the opposite shore he saw a man limping toward him. He was dragging a large snapping turtle. "What troubles your walk?" asked Hayĕntwatha. "I have a blister on my crotch" answered the man.

Then said Hayĕntwatha to himself, "In the future this man and his brothers with all his female relations shall be known as Hodī-ho′ō′ĕn′h. They have blisters on their crotches and they shall be of the Small Turtle Clan."

Then again he proceeded on his journey and after a time he saw an old corn field and a field shelter house with a roof of stalks. So he went there for a camp.

The great sorrow had not left him so he sat by his campfire and talked to himself. Then he strung up the shells and placed three strings on a pole laid across two upright poles. He continued to talk.

[1] The original confederates were the Mohawk, Oneida and Onondaga.

A little girl saw the smoke of the campfire and went out into the field. She went close to the shelter house and listened to what Hayĕntwatha said. Then she returned and told her father what she had seen. He then sent two men to invite Hayĕntwatha to the village.

Hayĕntwatha did not reply to them but with his head bowed before his fire he said aloud to himself, "These people should know that every invitation should be confirmed by a string of shells such as hang before me; they should give me a strand (ä-sa-na-tcik′)."

The men returned to their chief and told what they had heard. Then he ordered them to string up some beads of large porcupine quills and carry them to the stranger to become words of invitation. This they did and Hayĕntwatha said, "It is now right."

The warriors who came with the two messengers returned to the village and after smoking his pipe Hayĕntwatha went to the village with the two guides. At the settlement the council was in session and Hayĕntwatha was invited to sit on one side of the fire. The discussion was a spirited one and none of the head men could agree on any question. During the debate a great man came in. The room was crowded and the head man who had invited Hayĕntwatha arose and gave his place to the great man. The debate continued and Hayĕntwatha silently departed, angry at the slight he had received. In the council room the debate was as devoid of result as before when the head man arose and said, "I have staying with me a friend. He is a stranger and I do not know from whence he came. Perhaps he can settle our dispute."

Then everyone looked for the stranger but Hayĕntwatha was not there. The head man could not find him. So then the head man said, "I think I have made a great mistake. He must have been a great man and I have offended him. He has magically disappeared."

So the man who was able to settle the quarrel of the people was not there.

When Hayĕntwatha left the council he journeyed on to the outskirts of another settlement and made a camp. Here he commanded his two guardian birds to come to him. Their names were Hă′-goks′ and Skadjiē′na.[1] He said, "Go and see if smoke arises from any settlement."

Then the birds arose and when they returned they said, "Smoke arises from the Oneida villages."

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[1] Said by some informants to have been two human messengers bearing these names and not actually birds.

So then Hayĕntwatha went eastward and in all the Oneida towns he heard the people talking about the Great Law and about the Great Peace. Dekanawida had told of it but the people failed to understand it. So then Hayĕntwatha said, " I must meet that man for my mind is not yet unburdened." So he continued on his journey down the river, toward the Mohawk country, for he greatly wished to see Dekanawida.

APPENDIX A

THE PASSAMAQUODDY WAMPUM RECORDS

RECORDED BY J. D. PRINCE[1]

Many bloody fights had been fought, many men, women and children had been tortured by constant and cruel wars until some of the wise men among the Indians began to think that something must be done, and that whatever was to be done should be done quickly. They accordingly sent messengers to all parts of the country, some going to the south, others to the east, and others to the west and northwest. Some even went as far as the Wabanaki.[2] It was many months before the messengers reached the farthest tribes. When they arrived at each nation, they notified the people that the great Indian nations of the Iroquois, Mohawks and others had sent them to announce the tidings of a great Lagootwagon or general council for a treaty of peace. Every Indian who heard the news rejoiced, because they were all tired of the never-ending wars. Every tribe, therefore, sent two or more of their cleverest men as representatives to the great council.

When all the delegates were assembled they began to deliberate concerning what was best to do, as they all seemed tired of their evil lives. The leading chief then spoke as follows: "As we look back upon our blood-stained trail we see that many wrongs have been done by all of our people. Our gory tomahawks, clubs, bows and arrows must undoubtedly be buried for ever." It was decided, therefore, by all concerned to make a general Lagootwagon or treaty of peace, and a day was appointed when they should begin the rites.

For seven days, from morning till night, a strict silence was observed, during which each representative deliberated on the speech

[1] See "Klooskape, The Master." Funk & Wagnalls Co., 1899.

[2] According to Indian tradition, six Iroquoian tribes united in confederation in the interests of peace. This was the famous League of the Six Nations: Onondagas, Mohawks, Oneidas, Senecas, Cayugas and Tuscaroras. The first five of these completed their league as early as the middle of the fifteenth century under the Onondaga chief Hiawatha. The object of the federation was to abolish war altogether (see Brinton, The American Race, p.82,83). It is evident that the Passamaquoddy tradition embodied in this part of the Wampum Records refers to these proposals made by their Iroquois neighbors.

he should make and tried to discover the best means for checking the war. This was called the " Wigwam of silence."

After this, they held another wigwam called m'sittakw-wen tle-westoo, or " Wigwam of oratory." The ceremonies then began. Each representative recited the history of his nation, telling all the cruelties, tortures and hardships they had suffered during their wars and stating that the time had now come to think of and take pity on their women and children, their lame and old, all of whom had suffered equally with the strongest and bravest warriors. When all the speeches had been delivered, it was decided to erect an extensive fence and within it to build a large wigwam. In this wigwam they were to make a big fire and, having made a switch or whip, to place " their father " as a guard over the wigwam with the whip in his hand. If any of his children did wrong he was to punish them with the whip. Every child of his within the inclosure must therefore obey his orders implicitly. His duty also was to keep replenishing the fire in the wigwam so that it should not go out. This is the origin of the Wampum laws.

The fence typified a treaty of peace for all the Indian nations who took part in the council, fourteen in number, of which there are many tribes. All these were to go within the fence and dwell there, and if any should do wrong they would be liable to punishment with the whip at the hands of " their father." The wigwam within the fence represented a universal house for all the tribes, in which they might live in peace, without disputes and quarrels, like members of one family. The big fire (ktchi squt) in the wigwam denoted the warmth of the brotherly love engendered in the Indians by their treaty. The father ruling the wigwam was the great chief who lived at Caughnawaga. The whip in his hand was the type of the Wampum laws, disobedience to which was punishable by consent of all the tribes mentioned in the treaty.

After this, they proceeded to make lesser laws, all of which were to be recorded by means of wampum, in order that they could be read to the Indians from time to time. Every feast, every ceremony, therefore, has its own ritual in the wampum; such as the burial and mourning rites after the death of a chief, the installation of a chief, marriage etc. There were also salutation and visiting wampum.

CEREMONIES CUSTOMARY AT THE DEATH OF A CHIEF

When the chief of the tribe died, his flag pole was cut down and burnt, and his warlike appurtenances, bows and arrows,

tomahawk and flag were buried with him. The Indians mourned for him one year, after which the Pwutwusimwuk or leading men were summoned by the tribe to elect a new chief. The members of one tribe alone could not elect their own chief; according to the common laws of the allied nations, he had to be chosen by a general wigwam. Accordingly, after the council of the leading men had assembled, four or six canoes were dispatched to the Micmac, Penobscot and Maliseet tribes if a Passamaquoddy chief had died.[1] These canoes bore each a little flag in the bow as a sign that the mission on which the messengers came was important. On the arrival of the messengers at their destination, the chief of the tribe to which they came called all his people, children, women and men, to meet the approaching boats. The herald springing to land first sang his salutation song (n'skawewintuagunul), walking back and forth before the ranks of the other tribe. When he had finished his chant the other Indians sang their welcoming song in reply.

As soon as the singing was over they marched to some imwewigwam or meeting house to pray together. The visiting Indians were then taken to a special wigwam allotted to their use over which a flag was set. Here they were greeted informally by the members of the tribe with hand-shaking etc. The evening of the first day was spent in entertaining the visitors.

On the next day the messengers sent to the chief desiring to see all the tribe assembled in a gwandowanek or dance hall. When the tribe had congregated there, the strangers were sent for, who, producing their strings of wampum to be read according to the law of the big wampum, announced the death of the chief of their tribe, "their eldest boy" (ktchi w'skinosismowal), and asked that the tribe should aid them to elect a new chief. The chief of the stranger tribe then arose and formally announced to his people the desire of the envoys, stating his willingness to go to aid them, his fatherless brothers, in choosing a new father. The messengers, arising once more, thanked the chief for his kindness and appointed a day to return to their own people.

The ceremony known as kelhoochun then took place. The chief notified his men that his brothers were ready to go, but that they

[1] From here on the recorder mentions only the neighboring Algonkin tribes as belonging to the federation which he has in mind. The northern Algonkin tribes were very probably in a loose federation with the Iroquois merely for purposes of intertribal arbitration. These Algonkin clans themselves, however, seem to have been politically interdependent, as one clan could not elect a chief without the consent of all the others.

should not be allowed to go so soon. The small wampum string called kellhoweyi or prolongation of the stay was produced at this point, which read that the whole tribe, men, women and children, were glad to see their brothers with them and begged them to remain a day or two longer; that "our mothers" (kigwusin), that is, all the tribal women, would keep their paddles yet a little while. This meant that the messengers were not to be allowed to depart so soon.

Here followed the ceremony called N'skahudin. A great hunt was ordered by the chief and the game brought to the meeting hall and cooked there. The noochila-kalwet or herald went about the village crying wikw-poosaltin, which was intelligible to all. Men, women and children immediately came to the hall with their birch-bark dishes and sat about the game in a circle, while four or five men with long-handled dishes distributed the food, of which every person had a share. The feast was called kelhootwi-wikw-poosaltiu. When it was all over the Indians dispersed, but returned later to the hall when the messengers sang again their salutation songs in honor of their forefathers, in reply to which the chief of the tribe sang his song of greeting.

When the singing was over the chief seated himself in the midst of the hall with a small drum in one hand and a stick in the other. To the accompaniment of his drum he sang his k'tumasooi-n'tawagunul or dance songs, which was the signal for a general dance, followed by another feast.

The envoys again appointed a day to return, but were deterred in the same manner. As these feasts often lasted three weeks or a month, a dance being held every night, it was frequently a long time before they could go back to their own tribe, because the chief would detain them whenever they wished to return. Such was the custom.

THE CEREMONY OF INSTALLATION

When they reached home, however, and the embassies from the other Wạbanaki tribes had also returned, the people of the bereaved tribe were summoned to assemble before the messengers, who informed them of the success of their mission. When the delegates from the other tribes, who had been appointed to elect the chief, had arrived and the salutation and welcome ceremonies had been performed, an assembly was called to elect the chief.

This took place about the second day after the arrival of the other Wabanaki representatives. A suitable person, a member of the bereaved tribe, was chosen by acclamation for the office of chief.

If there was no objection to him a new flag pole was made and prepared for raising, and a chief from one of the kindred tribes put a medal of wampum on the chief-elect who was always clothed in new garments. The installing chief then addressed the people, telling them that another "eldest boy" had been chosen, to whom they owed implicit obedience. Turning to the new chief, he informed him that he must act in accordance with the wishes of his people. The main duties of a chief were to act as arbiter in all matters of dispute, and to act as commander in chief in case of war, being ready to sacrifice himself for the people's good if necessary.

After this ceremony they marched to the hall, where another dance took place, the new chief singing and beating the drum. A wife of one of the other chiefs then placed a new deer skin or bear skin on the shoulders of the new chief as a symbol of his authority, after which the dance continued the whole night.

The officers of the new chief (geptins) were still to be chosen. These were seven in number and were appointed in the same manner and with the same ceremonies as the chief. Their duties, which were much more severe, were told them by the installing chief. The flag pole, which was the symbol of the chief, was first raised. The geptins stood around it, each with a brush in his hand, with which they were instructed to brush off any particle of dust that might come upon it. This signified that it was their duty to defend and guard their chief and that they should be obliged to spill their blood for him, in case of need and in defense of the tribe. All the women and children and disabled persons in the tribe were under the care of the geptins. The chief himself was not allowed to go into battle, but was expected to stay with his people and to give orders in time of danger.

After the tribal officers had been appointed, the greatest festivities were carried on; during the day they had canoe races, foot races and ball playing, and during the night, feasting and dancing. The Indians would bet on the various sports, hanging the prizes for each game on a pole. It was understood that the winner of the game was entitled to all the valuables hung on this pole. The festivities often lasted an entire month.

THE MARRIAGE CEREMONY: THE ANCIENT RITE

It was the duty of the young Indian man who wished to marry to inform his parents of his desire, stating the name of the maiden. The young man's father then notified all the relatives and friends

of the family that his son wished to marry such and such a girl. If the friends and relations were willing, the son was permitted to offer his suit. The father of the youth prepared a clean skin of the bear, beaver or deer, which he presented to his son. Provided with this, the suitor went to the wigwam of his prospective bride's father and placed the hide at the back of the wigwam or nowteh. The girl's father then notified his relations and friends, and if there was no objection, he ordered his daughter to seat herself on the skin, as a sign that the young man's suit was acceptable. The usual wedding ceremonies were then held, namely, a public feast, followed by dancing and singing, which always lasted at least a week.

THE MARRIAGE CEREMONY IN LATER DAYS

After the adoption of the Wampum laws the marriage ceremony was much more complicated.[1]

When the young man had informed his parents of his desire to marry and the father had secured the consent of the relations and friends, an Indian was appointed to be the Keloolwett or marriage herald, who, taking the string of wampum called the Kelolwawei, went to the wigwam of the girl's father, generally accompanied by as many witnesses as cared to attend. The herald read the marriage wampum in the presence of the girl and her father, formally stating that such and such a suitor sought his daughter's hand in marriage. The herald, accompanied by his party, then returned to the young man's wigwam to await the reply. After the girl's father had notified his relatives and friends and they had given their consent, the wedding was permitted to go on.

The usual ceremonies then followed. The young man first presented the bride-elect with a new dress. She, after putting it on, went to her suitor's wigwam with her female friends, where she and her company formally saluted him by shaking hands. This was called wulisakowdowagon or salutation. She then returned to her father's house, where she seated herself with her following of old women and girls. The groom then assembled a company of his friends, old and young men, and went with them to the bride's wigwam to salute her in the same manner. When these salutations were over a great feast was prepared by the bride, enough for all the people, men, women and children. The bridegroom also prepared a similar feast. Both of these dinners were cooked in the

[1] Mitchell interpolated this remark.

open air and when the food was ready they cried out k'waltewall "your dishes." Every one understood this, which was the signal for the merry-makers to approach and fall to.

The marriage ceremonies, however, were not over yet. The wedding party arrayed themselves in their best attire and formed two processions, that of the bride entering the assembly wigwam first. In later times it was customary to fire a gun at this point as a signal that the bride was in the hall, whereupon the groom's procession entered the hall in the same manner, when a second gun was fired. The geptins of the tribe and one of the friends of the bride then conducted the girl to the bridegroom to dance with him. At midnight after the dancing a supper was served, to which the bride and groom went together and where she ate with him for the first time. The couple were then addressed by an aged man (noiimikokemit) on the duties of marriage.

Finally, a number of old women accompanied the newly made wife to her husband's wigwam, carrying with them her bed clothes. This final ceremony was called natboonan, taking or carrying the bed.

APPENDIX B

SKETCHES OF AN INDIAN COUNCIL, 1846

(From Schoolcraft's Census of 1845)

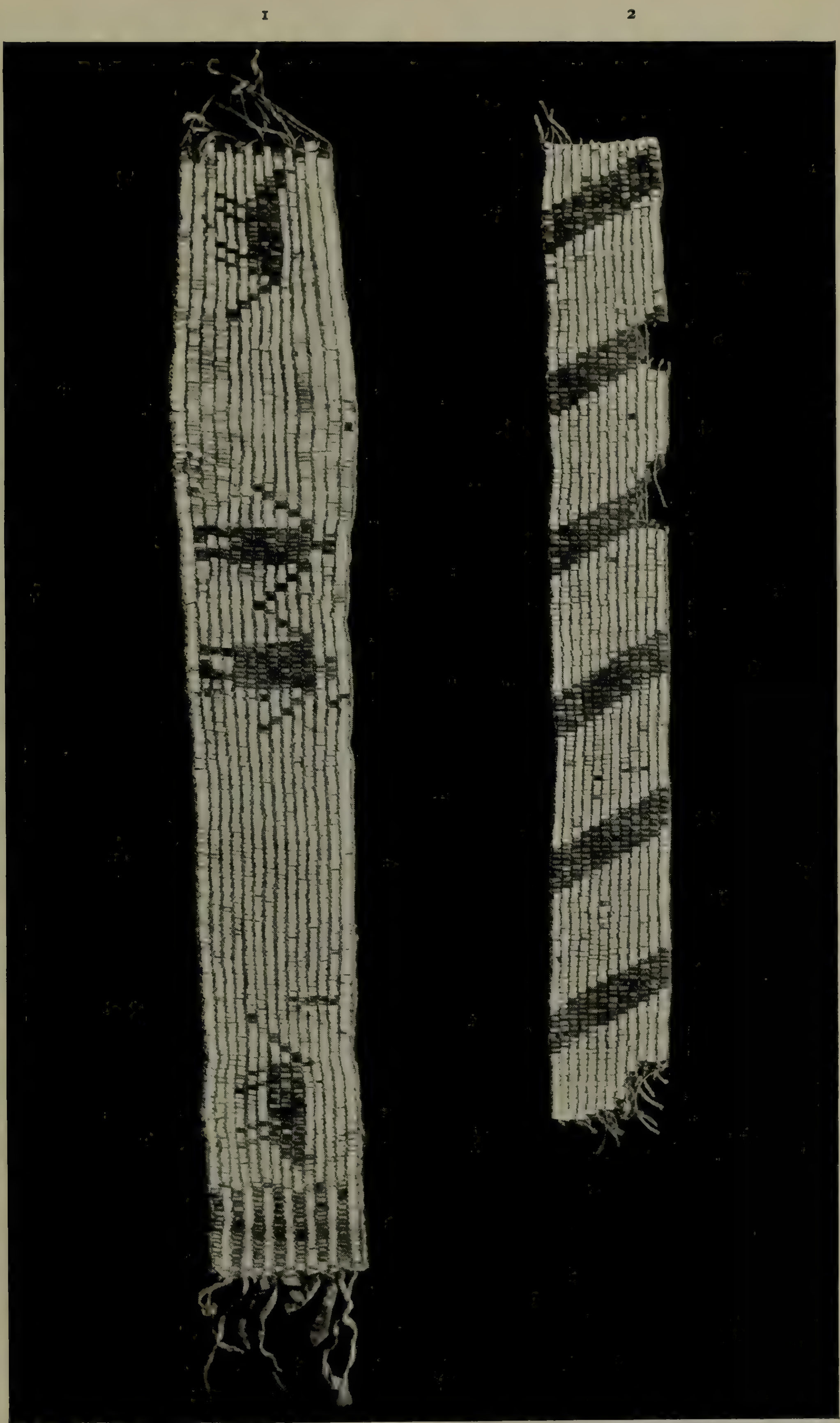
A grand council of the confederate Iroquois was held last week, at the Indian council house on the Tonawanda Reservation, in the county of Genesee. Its proceedings occupied three days, closing on the third instant. It embraced representatives from all the Six Nations — the Mohawk, the Onondaga, the Seneca; and the Oneida, the Cayuga and the Tuscarora. It is the only one of the kind which has been held for a number of years, and is the last which will ever be assembled with a full representation of all the confederate nations.

With the expectation that the council would commence on Tuesday, two or three of us had left Rochester so as to arrive at the council house Monday evening; but owing to some unsettled preliminaries, it had been postponed till Wednesday. The Indians from abroad, however, arrived at the council grounds, or in their immediate vicinity, on Monday; and one of the most interesting spectacles of the occasion, was the entry of the different nations upon the domain and hospitality of the Senecas, on whose ground the council was to be held. The representation of Mohawks, coming as they did from Canada, was necessarily small. The Onondagas, with the acting Tod-o-dah-hoh of the confederacy, and his two counsellors, made an exceedingly creditable appearance. Nor was the array of Tuscaroras, in point of numbers at least, deficient in attractive and imposing features.

Monday evening we called upon, and were presented to, Blacksmith, the most influential and authoritative of the Seneca sachems. He is about 60 years old, is somewhat portly, is easy enough in his manners, and is well disposed and even kindly towards all who convince him that they have no sinister designs in coming among his people.

Jemmy Johnson is the great high priest of the confederacy. Though now 69 years old, he is yet an erect, fine looking, and energetic Indian, and is both hospitable and intelligent. He is in possession of the medal presented by Washington to Red Jacket in 1792 which among other things of interest, he showed us.

Plate 8



1 Wolf clan belt said to represent a pact of the Mohawk with the French
2 Tuscarora entrance belt

It would be incompatible with the present purpose to describe all the interesting men who there assembled, among whom were Captain Frost, Messrs Le Fort, Hill, John Jacket, Doctor Wilson and others. We spent most of Tuesday, and indeed much of the time during the other days of the week in conversation with the chiefs and most intelligent Indians of the different nations, and gleaned from them much information of the highest interest in relation to the organization, government and laws, religion, customs of the people, and characteristics of the great men, of the old and once powerful confederacy. It is a singular fact, that the peculiar government and national characteristics of the Iroquois is a most interesting field for research and inquiry, which has never been very thoroughly, if at all, investigated, although the historic events which marked the proud career of the confederacy, have been perseveringly sought and treasured up in the writings of Stone, Schoolcraft, Hosmer, Yates and others.

Many of the Indians speak English readily; but with the aid and interpretations of Mr Ely S. Parker, a young Seneca of no ordinary degree of attainment, in both scholarship and general intelligence, and who with Le Fort, the Onondaga, is well versed in old Iroquois matters, we had no difficulty in conversing with any and all we chose to.

About midday on Wednesday, the council commenced. The ceremonies with which it was opened and conducted were certainly unique, almost indescribable; and as its proceedings were in the Seneca tongue, they were in a great measure unintelligible, and in fact profoundly mysterious to the pale faces. One of the chief objects for which the council had been convoked, as has been heretofore editorially stated in the *American,* was to fill two vacant sachemships of the Senecas, which had been made by the death of the former incumbents; and preceding the installation of the candidates for the succession, there was a general and dolorous lament for the deceased sachems, the utterance of which, together with the repetition of the laws of the confederacy — the installation of the new sachems — the impeachment and deposition of three unfaithful sachems — the elevation of others in their stead, and the performance of the various ceremonies attended upon these proceedings, consumed the principal part of the afternoon.

At the setting of the sun, a beautiful repast, consisting of an innumerable number of rather formidable looking chunks of boiled fresh beef, and an abundance of bread and succotash, was brought into the council house. The manner of saying grace on this

occasion was indeed peculiar. A kettle being brought, hot and smoking from the fire, and placed in the center of the council house, there proceeded from a single person, in a high shrill key, a prolonged and monotonous sound, resembling that of the syllable *wah* or *yah.* This was immediately followed by a response from the whole multitude, uttering in a low and profoundly guttural but protracted tone, the syllable *whe* or *swe,* and this concluded grace. It was impossible not to be somewhat mirthfully effected at the first hearing of grace said in this novel manner. It is, however, pleasurable to reflect that the Indians recognize the duty of rendering thanks to the Divine Being in some formal way, for the bounties and enjoyments which he bestows; and were an Indian to attend a public feast among his pale faced brethern he would be effected, perhaps to a greater degree of marvel, at witnessing a total neglect of this ceremony, than we were at his singular way of performing it.

After supper commenced the dances. All day Tuesday, and on Wednesday, up to the time that the places of the deceased sachems had been filled, everything like undue joyfulness had been restrained. This was required by the respect customarily due to the distinguished dead. But now, the bereaved sachemships being again filled, all were to give utterance to gladness and joy. A short speech from Captain Frost, introductory to the employments of the evening, was received with acclamatory approbation; and soon eighty or ninety of these sons and daughters of the forest — the old men and the young, the maidens and matrons — were engaged in the dance. It was indeed a rare sight.

Only two varieties of dancing were introduced the first evening — the trotting dance and the fish dance. The figures of either are exceedingly simple, and but slightly different from each other. In the first named, the dancers all move round a circle, in a single file, and keeping time in a sort of trotting step to an Indian song of Yo-ho-ha, or yo-ho-ha-ha-ho, as sung by the leaders, or occasionally by all conjoined. In the other, there is the same movement file round a circle, but every two persons, a man and a woman, or two men, face each other, the one moving forward and the other backward, and all keeping step to the music of the singers, who are now, however, aided by a couple of tortoise or turtle shell rattles or an aboriginal drum. At regular intervals there is a sort of cadence in the music, during which a change of position by all the couples take place, the one who had been moving backward

taking the place of the one moving forward, when all again move onward, one-half of the whole, of course, being obliged to follow on by advancing backward.

One peculiarity in Indian dancing would probably strongly commend itself to that class among pale-faced beaux and belles denominated the bashful; though perhaps it would not suit others as well. The men, or a number of them, usually begin the dance and the women, or each of them, selecting the one with whom she would like to dance, presents herself at his side as he approaches, and is immediately received into the circle. Consequently, the young Indian beau knows nothing of the tact required to handsomely invite and gallantly lead a lady to the dance; and the young Indian maiden presents her personage to the one she designs to favor, and thus quietly engage herself in the dance. And, moreover, while an Indian beau is not necessarily obliged to exhibit any gallantry as toward a belle, till she has herself manifested her own pleasure in the matter, so therefore the belle can not indulge herself in vacillant flirtations with any considerable number of beaux, without being at once detected.

On Tuesday the religious ceremonies commenced, and the council from the time it assembled, which was about 11 o'clock a. m., till 3 or 4 o'clock p. m., gave the most serious attention to the preaching of Jemmy Johnson, the great high priest, and the second in the succession under the new revelation. Though there are some evangelical believers among the Indians, the greater portion of them cherish the religion of their fathers. This, as they say, has been somewhat changed by the new revelation, which the Great Spirit made to one of their prophets about 47 years ago, and which, as they also believe, was approved by Washington. The profound regard and veneration which the Indian has ever retained toward the name and memory of Washington is most interesting evidence of his universally appreciated worth; and the fact that the red men regard him not merely as one of the best, but as the very best man that ever has existed, or that will ever exist, is beautifully illustrated in a single credence which they maintain even to this day, namely, that Washington is the only white man that has ever entered heaven, and is the only one who will enter there, till the end of the world.

Among the Senecas, public religious exercises take place but once a year. At these times Jemmy Johnson preaches hour after hour, for three days; and then rests from any public discharge of ecclesiastical offices the remaining 362 days of the year. On this, an

unusual occasion, he restricted himself to a few hours in each of the last two days of the council. We were told by young Parker, who took notes of his preaching, that his subject matter on Tuesday abounded with good teachings, enforced by appropriate and happy illustrations and striking imagery. After he had finished, the council took a short respite. Soon, however, a company of warriors ready and eager to engage in the celebrated " corn dance," made their appearance. They were differently attired; while some were completely enveloped in a closely fitting and gaudy colored garb, others, though perhaps without intending it, had made wonderfully close approaches to an imitation of the costume said to have been so fashionable in many parts of the state of Georgia during the last hot summer, and which is also said to have consisted simply of a shirt collar and a pair of spurs. But in truth, these warriors, with shoulders and limbs in a state of nudity, with faces bestreaked with paints, with jingling trinkets dangling at their knees, and with feather war-caps waving above them, presented a truly picturesque and romantic appearance. When the center of the council house had been cleared, and the musicians with the shell rattles had taken their places, the dance commenced; and for an hour and a half, perhaps two hours, it proceeded with surprising spirit and energy. Almost every posture of which the human frame is susceptible, without absolutely making the feet to be uppermost, and the head for once to assume the place of the understanding, was exhibited. Some of the attitudes of the dancers were really imposing, and the dance as a whole could be got up and conducted only by Indians. The women in the performance of the corn dance, are quite by themselves, keeping time to the beat of the shells, and gliding along sideways, scarcely lifting their feet from the floor.

It would probably be well if the Indians everywhere could be inclined to refrain at least from the more grotesque and boisterous peculiarities of this dance. The influence of these can not be productive of any good; and it is questionable whether it would be possible, so long as they are retained, to assimilate them to any greater degree of civilization or to more refined methods of living and enjoyment, than they now possess. The same may be said of certain characteristics of the still more vandalic war dance. This, however, was not introduced at the council.

A part of the proceedings of Friday, the last day of the council, bore resemblance to those of the preceding day. Jemmy Johnson resumed his preaching, at the close of which the corn dance was again performed, though with far more spirit and enthusiasm than

at the first. Double the number that then appeared — all hardy and sinewy men, attired in original and fantastic style, among whom was one of the chiefs of the confederacy, together with forty or fifty women of the different nations — now engaged and for two hours persevered in the performance of the various complicated and fatiguing movements of this dance. The appearance of the dusky throng, with its increased numbers and, of course, apportionably increased resources for the production of shrill whoops and noisy stamping, and for the exhibition of striking attitudes and rampant motions, was altogether strange, wonderful and seemingly superhuman.

After the dance had ceased another kind of "sport," a well-contested foot race, claimed attention. In the evening after another supper in the council house, the more social dances — the trotting, the fish, and one in which the women alone participated — were resumed. The fish dance seemed to be the favorite; and being invited to join it by one of the chiefs, we at once accepted the invitation, and followed in mirthful chase of pleasure, with a hundred forest children. Occasionally the dances are characterized by ebullitions of merriment and flashes of real fun; but generally a singular sobriety and decorum are observed. Frequently, when gazing at a throng of sixty or perhaps a hundred dancers, we have been scarcely able to decide which was the most remarkable, the staid and imperturbable gravity of the old men and women, or the complete absence of levity and frolicsomeness in the young.

The social dances of the evening, with occasional speeches from the sachems and chiefs, were the final and concluding ceremonies of this singular but interesting affair. Saturday morning witnesses the separation of the various nations, and the departure of each to their respective homes.

The writer would like to have said a word or two in relation to the present condition and prospects of the Indians, but the original design in regard to both the topics and brevity of this writing having been already greatly transcended, it must be deferred. The once powerful confederacy of the Six Nations, occupying in its palmy days the greater portion of New York State, now number only a little over 3000. Even this remnant will soon be gone. In view of this, as well as of the known fact that the Indian race is everywhere gradually diminishing in number, the writer can not close without invoking for this unfortunate people, renewed kindliness and sympathy and benevolent attention. It is true that, with some few

exceptions, they possess habits and characteristics which render them difficult to approach; but still they are only what the Creator of us all has made them. And let it be remembered, it must be a large measure of kindliness and benevolence, that will repay the injustice and wrong that have been inflicted upon them.

R. S. G.

Rochester, October 7, 1845

APPENDIX C

MINUTES OF THE SIX NATIONS COUNCIL OF 1839[1]

LIST OF CHIEFS

Selected and inaugurated at the Six Nations' Council at the Six Nations Onondaga Council House, July 17, 1839

Sen (eca)

Of the Chicken Hawk Tribe

1 Shagĕhjowa, Joseph Silverheels of
Cattaraugus Reservation a Sachem of the
Long House of the Six nations
(Capt. Jones of Allegany, Gan'nage).

2 Sgăndiuhgwadi, Owen Blacksnake
James Robinson (Shaweegĕt) of Allegany
abdicated in favor of Blacksnake
A War Chief.

Of the Snipe tribe

1 Hah-jih-nya-wăs, Jacob Johnson
Walter Thomson (Honondahes) of Cattaraugus
Sachem of the Senecas

2 Degas swĕn'gaent, Davis Isaac
(English name not known) (Othowă) of Cattaraugus
War Chief.

Of the Swan tribe —

1 Deyúgăháshă, John Mitten
(Old Greenblanket, Don dae hañ) of Buffalo reservation.
Sachem or as we might say sub-sachem for the Senecas, but not entitled to a seat in the Six Nations' Council

2 Ga'năyuehse. James Pierce
English name not known (Toa'wihdoh)
War Chief.

Of the Deer Tribe

1 Swaowaeh, Jonah
White Chief Deganohsogă of Buffalo reservation
War Chief

2 Dóhsihdásgowa, John Baldwin
(George White Sa'gonondano of Buffalo.)
War Chief

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[1] From the original manuscript.

3 Hăondyeyah, Lewis Kennedy
(Capt. M'Gee Thoiwae) of Tonawanda
Sachem of the Senecas.

These four clans are brethren
Of the Wolf tribe
1 Deonihhogă'hwă, Blacksmith
Little Johnson of Buffalo (Jă-oyah-geăh) deposed
of Tonawanda —
Sachem of the Six Nations
2 Ganiyās, John Dickie
(No English name) (Dijihhnak) of Cattaraugus
War chief and runner under the preceding.
3 Degaăont, John Kennedy jr
(No English name) (Gagóh) of Buffalo
War Chief
4 Gásgaodoh, John Joshua Bluesky
(Two Guns) Gihdoondoh of Buffalo
Killed in battle of Chippeway
Sachem of the Senecas
5 Hayahsajih, Peter Johnson
(Old Two Guns, brother
of the preceding.) (Degeyáhgoh)
War Chief
6 Gayáhsodoh George Green Blanket
(No English name) (Gonyus,)
Buffalo
War Chief
7 Dagéhsahēh Isaac Shanks
(Reuben James) (Jiyakhoh)
Tonawandi
Sachem of the Senecas
Of *the Turtle tribe.*
1 Hadogut Jacob Shongo
(No English name) Waonohsihdeh
of Allegany
Sachem of Seneca
2 Gahnase Abram John
(No English name) (Ganăyáhseh)
Of Cattaraugus
Sachem of Senecas

3 Ganĭhdadĕháoh
(No English name) Danl Spring
of Tonawandi
War Chief. James, Spring
4 Gahnăodoh Ganănwĕhdŏoh
(Thomson S. Harris)
(deposed) Buffalo
War Chief
Speaker for the women.
Of the Beaver tribe
1 Aanishădekhah
Abram Johny John
Tall Chief Howanyaondyo
of Genesee Buffalo
Sachem for the Senecas
2 Ohgahdont Isaac Johny John
Guardian of the preceding during his minority
3 Doăhsah Hemlock
(Jack Berry) (Jinohsowă)
Buffalo
Sachem for the Senecas
4 Dayagodăhseh George Turkey
(Jack Snow) (Dyneah)
Cattaraugus
War Chief
5 Hayă'ndagă'nyahháh
Joe Hemlock Peter White
Thayah'dah'ah
War Chief Cattaraugus
Of the Bear Clan
1 Găhgwasah Saul Logan
Shoiwagayăt
Buffalo
War Chief
2 Aodogwĕh Jack Doxtator
Hajă'anoh
Buffalo
War Chief
These five Clans are brothers like the preceding four.
Of the Cayuga Nation
Of the Swan Tribe

1 Wăowawănaok, Peter Wilson
No English name (Dyawegaathet)
Buffalo
Sachem of the Cayugas
2 Ganyáh'geodoh Jacob Seneca
Hahsegwih
Buffalo
War Chief and runner for the preceding.
Of the Snipe Clan.
1 Gendăohoh' Joseph Peter
James Young Darhsas
War Chief

The preceding minutes were taken at the time of the transaction recorded and are the original thereof.

Asher Wright

RECORD OF A CONDOLENCE COUNCIL

The Mourning Council for the raising of chiefs

See writing on letter & consult other interpreters for the full meaning of the rest of the song.

Very mournful and solemn "There lays a number of with their horns on!! (Emblems of power like Hebrews)

Rehearsing the ancient custom that when they come we will give them a part of the five, (as he did in the beginning of the ceremony) Here ends the first song.

This was sung by Hyah'dajiwak after Col. Silversmith had presented the five as above. Then Elijah Williams answered by alluding to the loss they had & gave a string of wampum recounted the meanings of the several strings. Thanks them for wiping away their tears & this day thank the Great Spirit that they can thus cleanse away their grief and smoke the pipe of peace together, & then replies in a simular manner. We have come and found you also mourning and we also wipe away your tears, etc. Then Hayahdijiwak informed them that Gov. Blacksnake would take the lead of the Oneida party.

Then the Seneca side started —

(Dan'a says that if any portion of the Six Nations should go off he will be .... the confederacy)

Soon after the other side led by Blacksnake and young Jones repaired to the Council House and were received there by others who were seated there. Then came waiting & for many minutes one of the Oneidas second in the march walked the floor carrying the bag of old things & sang a wailing song, being frequently answered by the other side with a long wail & once by Elijah Williams. (What must be the feeling of these men.) Again Williams wails in a high tone & then others in a suppressed note an octave below. Wms. wails again & the low note is repeated & the bag bearer goes on singing. Now the wail and low tone are responded from the other side of the house. (I believe in his song he is repeating the names of the hadiyanne & then offices) of all the Six Nations. Now he is upon the Onondagas, and now they wail again as before. Now again. Now again. Is it repeated when he is coming to the names of the dead? Or is it at the finishing of those who belong to the same tribe? The latter I think or both.

Hai! Hai gayahaagweniohgwe!

Now he is upon the Cayugas. The exclamation hai! hai! seems a mourning interjection at the beginning of every sentence, between all the simple sentences & at the close of every paragraph. (Once Wms. made a little mistake & began to wail a word or two too soon & I noticed a little smiling) Now he is upon the Senecas. And now done & he has sat down by the side of Elijah Williams & now he has risen & began to speak instead of singing & desired them all to hear & said I have spoken the old way, continue it for one benefit, let it be followed forever.

Then silence and something which seemed like a consultation for several minutes followed. At length blankets were brought and a cord stretched across the Council House so as to separate the two parties from each other and cut off communication. Then another long interval of waiting. Then a bench was brought in to the Cayuga side and the wampum laid out before the masters of ceremonies, preparatory to the songs etc. These songs are the several articles of the ancient confederacy. Art 1 *Hai hai! Hai hi hi haih ne* etc. closing with a semitone downward slide of the voice etc.

It was so made everything was right when altogether they did it. There a relationship was made between them. (Song and response regular always interspersed with hai etc.) A chief warrior i. e. This wampum is so called, I suppose a chief or great woman. It was by their transaction that this operation goes forward.

After singing thus far he rose and made a wonderful speech to the dead man who invented the ceremonies, stating that, we have heard from our forefathers that these Nations will become extinct but we have now come to raise up chiefs and let the people hear the laws of our forefathers. Then he sung over the same speech.

Then Elijah Williams rose & recounted what was done in ancient times something like a declaration of independence repeating the names of the nations, or the others, united in one house & of the Sachems addressing the speech to "Ak sut" i. e. the other side, I suppose regarding them as the mother as it were of the Confederacy. (Here needs more inquiry)

Speaking of Ganinduiyes who used to live at Tonawanta, called him a Long Hickory Tree. After he had finished he received four papers of tobacco from the other side of the house & (shouted as it were.)

Then the other Oneida, Peter Williams, rose and took a string of wampum & explained the duties of a chief warrior as agreed by our forefathers that he must look to all the people and take care of them all old, young, women, children, creepers & the breast etc. So it was unanimously agreed (This was the black wampum)

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2 A short wampum signifying that when a chief is buried his grave must be leveled as soon as possible (i. e. a new chief must be chosen)

3 As soon as done always gives over to the other side & Wm. had another Comforting all who have been called to mourning by the death of Chiefs so as not to feel their loss always.

4 Now another sun breaks through the clouds and enlightened the faces which were sad before.

5 When the council five bands have been all scattered they must be gathered together again, i. e. when death has scattered the chiefs they must be collected again around the council fire and fill their places.

6 This is to comfort and pacify & satisfy the minds of the Chiefs, so that they can come together cheerfully to transact business.

7 If any of the chiefs go contrary to the law, the chiefs & chief warriors must consult the mother and follow her advice, thus, say we three of the children who are charging you.

8 We have poured water into the thirsty throats that they may be able to feel comfortable and speak freely.

9 He must carry his bag always whenever he goes anywhere he must go and stand by the corner of the fire and draw out his speech from the bag and if need be draw out his arrows also and declare war.

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10 Requesting them to appoint men to fill the places of the dead and tell us that we may know who they are — (And then he joked a little and said we three brothers have got through, it is time to adjourn & we can get to the tavern.)

Then Hayahdajiwak rose and requested the three brothers to have patience.

The curtain was put up in the other side of the house and preparations made to send back another set of wampums to be kept by this party.

(Meanwhile the four papers of tobacco had been divided among the three brothers.)

Now the other side commence with a kind of a shout to call attention & a repetition of the Songs nearly as before with a wampum before them on the little bench.

(It is said the words are the same as used by the Oneidas, although sung by an Onondaga. Probably a form either compounded to suit the occasion or perhaps one of the ancient languages as it was hundreds of years ago.)

In the song on the other side they mentioned the death of the fathers. Now these sing that the children are alive yet (of course we are not in mourning as before). Oyehgwohdoh was the name of the founder of the confederacy.

Sing again we must always hear what our ancestors have said and hear the Chief Woman who can call a council of the women and tell their voice in council among the chiefs & they are obliged to listen, as to a chief (or perhaps more seriously).

Now the wampums are sent back beginning with the black one.

It is true as you have said we have experienced a great loss etc. & we will do as well as we can etc.

(Note certain of the wampums not brought or delayed.)

Note the peculiar manner of recitation accent on the first syllable spoken & then again on the last. I think these replies accompanying the several strings of wampum were (or mean) " Now

the word shall go forth in relation to what you have spoken." "Our children (or younger brothers) all which you have said is wise. It is a good matter. You are wise. Now hear, all which you have spoken relative to this string of wampum is wise & we will do accordingly"—

But there is some variation in the words used according to the particular charge given by the party.

There are two sets of wampum & every time new chiefs are elected these are exchanged and kept till the next election by the two parties. (Did the two parties originate in the conjunction of the two confederacies in ancient times?)

Then he proceeded to bring forward the newly elected chiefs.

1 Shagehjowa- Joseph Silverheels a sachem. Degahnoge

You have requested us to tell us who we appoint to a co-worker with the chiefs in accordance with the example of our forefathers and now we have brought him forward, now know him, & know that he is called such an one.

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2 In the place of Robinson i. e. next to the chief warrior, Dyåñdinhgwadih, Owen Black Snake, Shaweegah'.

3 Twenty Summers, John Mitten.

(It is said that they have a string of wampum for every *name* and that these are kept so that the names may not be lost.)

4 A man not here, living at Alleghany in place of Ganāynihse, dead James Pierce.

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5 In the place of Gaswāhgaah, lives at Cattaraugus, Chief Warrior.

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6 Daandieyah, a young man at Tonawandi.

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7 Sgaowai, Jonah — White Chief, Gahnyagoh.

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8 Daáshihdasgowa, John Baldwin.

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9 Hahjihnyawāy Dea. Jacob Johnson
Walter Thompson.

10 In place of Little Johnson, (deposed) Dasnihogăhweh, Blacksmith of Tonawandi, Găoyah'gea.

11 Janiyăhs, not present. John Dicker.

12 Degaăout, John Kennedy.

13 Gasgaa-doh' John Joshua Sachem Gih'oh, in place of Two Guns, father of Henry Two Guns and Daniel, killed in battle of Chippeway—

14 Hayasajih, War Chief Gih'-oh.
Peter Johnson
(Degiyah'goh) in place of old Two Guns, brother of preceding.

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15 Gayáhsodoh', George Green Blanket in place of his grandfather some time since dead.

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16 Waádogut, Jacob Shongo, Dep. Sachem.

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17 Dagehsadēh young man from Tonawandi.

---

18 Gah'nase, Abram John sub Sachem.

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19 Gah'neodoh' James Spring in place of T. S. Harris deposed.

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20 Ganĕhdadĭhdăoh. A young man from Tonawandi.

Then Hayahdajiwak said that is all and Peter Williams begun to speak when Col. Silversmith beckoned him down and Hayahdajiwak proceeded.

21 To put in Saul Logan Gaăhgwas-Chief or head of the warriors.

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22 Othaoh'dogwĕh. Jack Doxtader, a chief of the warriors.

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23 In place of Jack Berry Doăsah (Sub Sachem) lives at the falls.

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24 Ohăneshadekhah'. Johnny Johnny John's son Sub-Sachem.

---

25 Isaac Johnny John. Guardian of preceding till he grew up.

---

26 Peter White of Cattaraugus Hayăndagănyathah.

---

27 George Turkey, Do Da-yagodăhseh War chiefs.

Now he says we have finished for the Senecas, Doorkeepers.

Then Peter Williams ansd. and charged the chiefs to take care of the people and not do anything contrary to the will of the people and not to trust in their own wisdom because they are elevated not to try to get above them but to promote their benefit and conform to the laws of the Six Nations.

If it had not been for the wampums which have been preserved it would have been difficult to have filled all these offices, of those which are dead, etc. etc.

Congratulates them highly and says there is only one thing lacking i. e. we begin to feel hungry — Then sat down but soon after rose. Held a wampum in his hand and made a speech & proceeded to put Peter Wilson 1 Waowawăvaok, a Cayuga chief in place of some old man and also Wm King resigned to him his office.

2 Jacob G. Seneca was put in his second Ganyahgeodoh.

3 Joseph Satourette in place of James Young, Gĕhdăodoh. — and made a speech afterward and presented a wampum but I had no interpreter at hand & could not understand whether another chief was put in or not.

About this time the provisions were brought in.

Peter Williams sat down & soon a shout was raised or wail. I do not know what to call it. (Elevated note drawn out & then the low octave followed) & was soon after repeated. After some moments repeated again and drawn out longer than before —

Then a long interval, while there were more provisions brought in, in which the assembled seemed to get in promiscuous conversation in a low tone and many were going out and coming in as if to relieve themselves after so long a confinement.

When Hayahdajiwak began to speak and as I supposed returned thanks and compliments & gave some notices etc. and then invited them according to the rule of our forefathers to take the food before they go out that they may be strengthened & then took a wampum and presented it to this side with an exhortation never to flinch from duty nor fail to come when called to a council of this kind. We exhort you and exhort ourselves.

Then Peter Williams took the same wampum and gave an answer that we were bound together again in fellowship according to the rules of our forefathers. We three brothers on this side of as you on that side and all together and keep the council houses in order. Thus we will all do according to the wishes of our forefathers.

Then Col. Silversmith sometime and exhorted them to keep the rules and create the new tunes and alluded to the dancing of the

night and told them of strangers coming from abroad wish to have anything to do with our young women we shall not withhold them but shall act according to the rule and those who do not wish to have anything to do with these things can have an opportunity to stay away etc.

(According to the old custom of the Northern & perhaps of all other Indians)

(And let them take warning, Dea. White says in a whisper to them not to act so bad.)

Ayo̱khiyatgah agwus weetgat agwus weetgă̱h agwus.

APPENDIX D

MINUTES OF THE COUNCIL OF THE SIX NATIONS, UPON THE CATTARAUGUS RESERVATION[1]

Dec. 1st, 1862

Andrew Snow made a few remarks that all the chiefs take places.

Dewathaaseh made a few congratulatory remarks of thanks. According to Indian customs thanked the Great Spirit for having preserved of those as were, now represented in council. He further stated that it devolved upon the Canada Indians to proceed with the exposition of the law.

Nowineehdoh' & Ganohgaihdawih' then opened the bag of wampum.

Nowineehdoh' arose & spake saying that we are now got together. When our forefathers finished the law they in the first place would return thanks — that was passed.

As far as was proceeded they would go on with the exposition of the law — In the first place think this, we are poor it will therefore depend our brother on the other side of the fire. That was the arrangement.

Seneca Johnson then arose & spoke exhorting the people to listen.

There is a goodly number — We therefore give thanks to the whole — It was the conclusion of my brother on the other side of the fire to devolve upon me.

In the first place you were told the other day of how the law came into existance, lastly the Tuscaroras came into the confederacy. Our forefathers foretold of the destiny of the Indians at the commencement of All. council. We have now come to that.

Long House used to sing when we were in power they went on in harmony. Hense they foretold what would happen.

They have now gone to their grave.

Their footsteps are a great way off that made the law.

What I say I am responsible for

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[1] From the original manuscript by N. H. Parker.

I will commence here. my told the truth in saying that the fire was here — Jonodagăantyewa. He was to have a stick when he could not do it he was to whoop and in less than no time the chiefs that is all true we could not go further than what was said by Hohsănehdeh'. The Long House says Six Nations — Tuscarora came in last —

5 nations made the law so & so — they were to be united by this law. If any one go through, his horns would fall off from his head.

Or if any should fall another should be raised.

But if any should refuse to come back by three time — they should take them off — Thus they arranged it, as it was to last forever (the law)

It is true in what he said by saying that they should pull the tree &c.

A Brand was taken from the real fire & laid into Canada after the expedition against the Indians. The chief went across the river. They had a great council at Găndayĕh by name. They said we should put up a tha — so no one could not get one (or over (?))

They went to work — the law — here it is. We do not know all Deaigă — & sa — know it all they have it written.

Concerning the tree —

Dasdaegih to watch the west root — south root Cherochees to charge of done by Six Nations East root 7 nations St Regis took charge of the ocean — North root. Ojigweh nation took charge of.

Long House did this large wampum there at Canada.

When peace was declared Long House put fire there into Canada to watch the north region — This is why they said the great white root should grow, & we should put our heads there should anyone strike the root &c.

This is the sum and substance of what the Canadians have.

Presented a belt with 12 black crosses. the words of Otawatgae-noot the name where a great council was held all summer.

Gosiweh was the name of the chief dwah'gahah'

They was to kill the chief of the Six Nations Sawanoonoh took the law

I said just now — Canada nations presented the wampum with a dark spot in the middle represent a bowl or dish with beaver tail in it — they also made a road — also presented a wampum — I say nothing about this wampum presenting it being the british —

This belt represents the encircling of the Six Nations similar to the one at Onondaga —

Israel Jimeson wished the speaker to turn it to the females. You see they the chiefs cannot get through.

Now this belt show the 12 nations said &c.

All the nations of the Six Nations were represented.

Dish represented with beaver meat in it They should eat together — use no knife for fear they should cut and draw blood.

This belt is with hearts to represent one heart. This the to other nations.

This belt Brant & Niăondahgowa throwed into the fire representing their repentence. So all must do

Again

I am merely what the proceedings were here and Canada 8 year council was held or called of all the nations & 4 years ago another was held of all the nations.

They were all united in the force of the law in Canada.

Now at this council many were present who were educated at that council.

As we now see here many are educated writing down the proceedings for future generations as it was the plan of our forefathers —

At this council a vote was taken whether they should adher to the law all rose.

This is all I can do as I fear I might injure feelings as there those present who made the law

But the main fire is not here Still it was your minds here to have the exposition of law again that was right. You now can see whether you have erred from the path of this law —

The white man has found his gun — now fighting. Let it not be so with us.

— Speech ended —

Additional remarks — It was the intention of the Long House wherever a council was held to bring the fires together. We heard that you was to take from us the fire that is the reason &c.

I will explain concerning this belt encircling the reason

6 arrows in a bundle

— We are weak —

The fathers & son's repentence this belt.

The Tuscarora said I am now at ease & therefore I shall not come to the fire.

I had a conversation with the British he asked me where I was going. I told him he said it was not right I protect you here — I said wonderful — your law & interest are connected by iron &c.

I said that those who erred were to be seen to &c.

S. S. D. Spoke It turned upon the Tuscaroras no chiefs here & it may true that he mind in peace as he is now able to take of chel,—

Sigwaih'seh is here installed at Onondaga he wishes to be in the confederacy —

Now and then you know they are divided still he will always be present & hopes that the other party will come to repentance —

Thomas Jimeson

Spoke & said he was happy to my friends — I wish to explain — before the sale of lands I used to talk with my friends old Canada. I thought I would try to live a different life — I bought lands — pay taxes — White man collected taxes first it was small 2d year I went & paid taxes again pd a little more than $20 — Path Master came next increased a little every year — came up to $40 — & 50 days roads Taxes. finally they petitioned for a corporation about 2 year it went through —City tax came in collector posted bills to pay on 1st of Oct. quite high about $110. Taxes must be pd or land sold — on the next Aug I pd again a little & on 1st of Dec since 5 year for 2 years I paid $50.— then officers changed time came. Tax fell off also on county Tax.

George Buck spoke in brief

The principal business of the day has gone by — it was concluded that the exposition of the law be made —

The council was called some time since Now you this day. You all Six Na have heard what was said by the keepers of the fire.

Both parties were here from Canada & here. you have heard all — ădwadegonih onăh

Detwathaahseh' spoke and said I will tell what happened where we came from — It was done in council. Sanctioned by Sardohahoh' Now I will tell about the chief. All claim him & for a reason — how we are to live encircling belt. I would say this is the same Six Nations joined in hands in the middle the house.

It is therefore important should he go through or over or go in ground to come out & some to do for the distruction of chil —

Again when he was chief he attended to interest of the land not to sell — also the interest of women chil — not to make chil.— or people cry — therefore his horns must fall on other nations west did not look to us — heads will roll

Chiefs skin must be thick & have patience.

Warriors beyond the circle & women (?) next therefore 3 times &c. chiefs must consider their (?) warriors then women

Then all shall come together to consider.

Again how a chief shall speak chiefs shall have control of Deaths of chiefs to sympathize with such family.

Chief shall hold office for life or good behavior.

Again we see our Canada friend. We see here the fire — the minds seems the same concerning the law. So you ought to do. I shall adher to it — Speech closed.

Wish to Amend

How the council should never speak of dividing land by disbanding the Na —

Again

When white man became brothers they traded land. Chiefs said All lands sold should be in common.

Nowineedoh' to speak for or in behalf of the chiefs from abroad.

listen brothers

You see us here Onondagas —All is exposed the law in full this day & all we can do —

You see us chiefs here this all they can do —

Their minds is, we have all construed the law should a council be called at some other place Then you may have the whole.

Again this thing is come to pass according to your mind —

It now devolve upon you to consider We all see our troubles — some day — it is therefore you should consider carefully.

How shall we do that our chil shall & have many days — Therefore you consider carefully in regard to this matter.

This much we say in brief — I would say again you are wise & you can see what to do.

Speech ended

Little Joe spoke

We have heard all the law exposed regard to what has been said. We have no time now tomorrow we will tell you.

Dec. 2d 1862

Council of the Six Nations resumed its deliberation by opening remarks of John Cook according to the custom of such councils —

Thanking the Great Spirit in preserving the lives of all now present & those who have come from abroad —

The council therefore was ready to proceed to *business.*

John Cook again spoke

saying his friends had now come from Canada as they were to do by and by.

It is this, that each tribe in N. Y. speak for themselves — to commune in order. When after all have spoken a certain one will be appointed to speak for the whole —

Tonawandas to council first, then Alle. then Catt — They were then ordered to take their accustomed seats

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Tonawandas

Jubez Ground spoke as follows:

That it was the duty in all such gatherings to exchange words of thanks before proceeding to business.

It was announced that we were the first to explain our troubles in council — We have divided. Some of us thought we were not going right — Blksmith and Jemmy Johnson were strait till their death Had they been living it would not have been so —

The other side tells us that we have erred because we would not comply with the law. So we said to them

Hence the party thought it best to have a council called to hear the exposition of the law — Our party is strong in the faith of the law.

You understand how we stand We are divided. We stand on the Six Na law & will stand by it — This is the feeling of our party. So you understand.

They have firm reliance on the law —

Now we tell how large our party is who *will* adher to the law 282.

We were told that belt was left for repentance — We have none to leave as they not believe they have erred.

The above is the actual number who voluntarily wished to on our side joined us without threats. Thus much we explain to you and our position *in brief*

Seneca Johnson said

The No of your party as I understand is 282. Now I ask the whole No at Ton

Isaac Doctor said that we do not know exactly but the other side has the majority — our party was once over 300 but fell off to the other side by threats, such as you will have no more goods & money if you keep the other side & you go to Kansas.

Alle —

Isaac Halftown —

I am appointed to speak for Alle & I will be brief as respects the condition of our people — we have what the Ton have said

They say that the other side has the majority how they (?) will do in that case I do not know.

The Alle would be glad to get back

They expect to take their band and explain to those left at home

Daniel Two Guns said that he speaks for the old folks — they have not let go the law

They will in the first place have to talk with the Pres. The Pres. have erred from the contract

In respect to our party we have a party but cannot say how many

So much in brief. Daniel 2 guns added

I said we do not know but we will go to work and see & let you know how many wish to adher to the Six Nations Law.

Isaac Halftown spoke again saying (the Alle) we will take hold of it.

I now ask concerning the wampum belt of repentance. You said &c

We Catt & Alle have erred we got white man law.

Shall we put the belt there too?

This is what I wish to know.

Little Joe said the thing today was going on what was to happen. The Cayugas also would have the privilege to speak he has erred it therefore may be of some help to those who have erred to hear them speak.

Joseph Isaac explained that they were ready to speak as soon

Seneca Johnson:

In reference to the question, let my brothers have patience until we answer to all that may be said.

Dr Wilson:

We will inform you how we feel we are much enlightened greatly in the exposition of the law — we therefore thank you — Now in reference to another matter, the white man long ago turned the Indians mind —

Concerning the arrows. This is to be of one mind — we come from the west through the white man's advice we now have small pieces of land. It now depends on you old folks to determine what to do —

Concerning the fires &c the white man has mixed his laws in criminal cases &c Then went on to relate the condition of Catt & Alle Reservations from the commencement up to this time, but still

the idea is (our idea) that the old fellows are still chiefs in Six Nations Council —

Our idea is that there is lack in the exposition of the law. Still we hope that at some future time the whole will come together & still their faith remained the same relying on the law of the Six Nations

Adjourned to eat —

John Cook spoke for women

Jisgoh'goh gave notice who was to make answer —

Silverman spoke

Ganyodioyoh

Dewathaah'sech' said that our destruction is being brought about by the white man

In regard to murder and theft the laws of the white man has jurisdiction also in case of liquor Laws by U. S. made

Our condition is this Our old chiefs beg laws for the protection of timber.

APPENDIX E

CERTAIN IROQUOIS TREE MYTHS AND SYMBOLS[1]

A student of Iroquoian folklore, ceremony, or history will note the many striking instances in which sacred or symbolic trees are mentioned. One finds allusions to such trees not only in the myths and traditions that have long been known to literature, and in the speeches of Iroquois chiefs in council with the French and English colonists, but also in the more recently discovered wampum codes and in the rituals of the folk-cults.

There are many references to the "tree of peace" in the colonial documents on Indian relations. Cadwallader Colden, for example, quotes the reply of the Mohawk chief to Lord Effingham in July 1684. The Mohawk agreed to the proposals for peace and their spokesman said: "We now plant a Tree who's tops will reach the sun, and its Branches spread far abroad, so that it shall be seen afar off; and we shall shelter ourselves under it, and live in Peace, without molestation." (Gives two beavers.)[2]

In a footnote Colden says that the Five Nations always express peace under the metaphor of a tree. Indeed, in the speech, a part of which is quoted above, the peace tree is mentioned several times.

In Garangula's reply to De la Barre, as recorded by Lahontan, are other references to the "tree." In his "harangue" Garangula said:

"We fell upon the Illinese and the Oumamis, because they cut down the Trees of Peace. . ." "The Tsonontouans, Gayogouans, Onnotagues, Onnoyoutes and Agnies declare that they interred the Axe at Cataracuoy in the Presence of your Predecessor the very Center of the Fort; and planted the Tree of Peace in the same place; 'twas then stipulated that the Fort should be used as a Place of Retreat for Merchants, and not as a Refuge for Soldiers. You ought to take care that so great a number of Militial Men as we now see . . . do not stifle and choke the Tree of Peace . . . it must needs be of pernicious Consequences to stop its Growth and hinder it to shade both your Country and ours with its Leaves." [3]

The examples cited above are only a few of many that might be quoted to show how commonly the Iroquois mentioned the peace

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1 A. C. Parker; an extract from Amer. Anthropologist, v. 14, No. 4, 1912.
2 Colden, History of the Five Nations, reprint, p. 58, New York, 1866.
3 Lahontan, Voyages, v. 1, p. 42. London, 1735.

tree. There are also references to the tree that was uprooted "to afford a cavity in which to bury all weapons of war," the tree being replanted as a memorial.

In the Iroquoian myth, whether Cherokee, Huron, Wyandot, Seneca or Mohawk, the "tree of the upper world" is mentioned, though the character of the tree differs according to the tribe and sometimes according to the myth-teller.

Before the formation of the lower or earth world the Wyandot tell of the upper or sky world and of the "big chief" whose daughter became strangely ill.[1] The chief instructs his daughter to "dig up the wild apple tree; what will cure her she can pluck from among its roots." David Boyle[2] wondered why the apple tree was called "wild" but that the narrator meant wild-apple and not wild apple is shown by the fact that in some versions the Seneca call the tree the crab-apple. The native apple tree with its small fruit was intended by the Indian myth-teller, who knew also of the cultivated apple and took the simplest way to differentiate the two.

With the Seneca this tree is described more fully. In manuscript left by Mrs Asher Wright, the aged missionary to the Seneca, I find the cosmologic myth as related to her by Esquire Johnson, a Seneca, in 1870. Mrs Wright and her husband understood the Seneca language perfectly and published a mission magazine in that tongue as early as 1838. Her translation of Johnson's myth should therefore be considered authentic. She wrote:

"There was a vast expanse of water. . . . Above it was the great blue arch of air but no signs of anything solid. . . . In the clear sky was an unseen floating island sufficiently firm to allow trees to grow upon it, and there were men-beings there. There was one great chief who gave the law to all the Ongweh or beings on the island. In the center of the island there grew a tree so tall that no one of the beings who lived there could see the top. On its branches flowers and fruit hung all the year round. The beings who lived on the island used to come to the tree and eat the fruit and smell the sweet perfume of the flowers. On one occasion the chief desired that the tree be pulled up. The great chief was called to look at the great pit which was to be seen where the tree had stood."

The story continues with the usual description of how the sky-mother was pushed into the hole in the sky and fell upon the wings of the waterfowl who placed her on the turtle's back. After this mention of the celestial tree in the same manuscript is the story of

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[2] Connelley, W. E., Wyandot Folk Lore. Topeka, 1889.

[2] Boyle, The Iroquois, in Archeological Report of Ontario for 1905, p. 147.

the central world-tree. After the birth of the twins, Light One and Toadlike (or dark) One, the Light One, also known as Good-minded, noticing that there was no light, created the " tree of light." This was a great tree having at its topmost branch a great ball of light. At this time the sun had not been created. It is significant, as will appear later, that the Good-minded made his tree of light one that brought forth flowers from every branch. After he had continued experimenting and improving the earth, " he made a new light and hung it on the neck of a being, and he called the new light Gaagwaa (ga gwa) and instructed its bearer to run his course daily in the heavens." Shortly after he is said to have " dug up the tree of light, and looking into the pool of water in which the stump (trunk) had grown, he saw the reflection of his own face and thereupon conceived the idea of creating Ongwe and made them both a man and a woman."

The central world-tree is found also in Delaware mythology, though so far as I can discover it is not called the tree of light. The Journal of Dankers and Slyter[1] records the story of creation as heard from the Lenape of New Jersey in 1679. All things came from a tortoise, the Indians told them. " It had brought forth the world, and in the middle of its back had sprung a tree upon whose branches men had grown." [2] This relation between men and the tree is interesting in comparison with the Iroquois myth, as it is also conceived to be the central world-tree. Both the Lenape and the Iroquois ideas are symbolic and those who delight in flights of imagination might draw much from both.

The Seneca world-tree is described elsewhere in my notes as a tree whose branches pierce the sky and whose roots extend to the waters of the underworld. This tree is mentioned in various ceremonial rites of the Iroquois. With the False Face Company, Hadigo sa sho o, for example, the Great Face, chief of all the False Faces, is said to be the invisible giant that guards the world tree (gaindowa ne). He rubs his turtle-shell rattle upon it to obtain its power, and this he imparts to all the visible false faces worn by the company. In visible token of this belief the members of the company rub their turtle rattles on pine-tree trunks, believing that thereby they become imbued with both the earth power and the sky power. In this use of the turtle-shell rattle there is perhaps a recognition of

[1] Journal of Voyage to New York in 1679–80, by Jasper Dankers and Peter Slyter, translated in Trans. L. I. Hist. Soc., v. I, 1867.

[2] With the New England Indians the idea was held that men were found by Glooskap in a hole by an arrow which he had shot into an ash tree.

the connection between the turtle and the world-tree that grows upon the primal turtle's back.

In the prologue of the Wampum Code of the Five Nations Confederacy we again find references to a symbolic "great tree." In the code of Dekanawide, the Iroquois culture hero exclaims:

"I am Dekanawide, and with the Five Nations' confederate lords (rodiyaner) I plant the Tree of the Great Peace. I plant it in your territory, Adodarho and the Onondaga nation, in the territory of you who are Fire Keepers.

"I name the tree the Tree of the Great Long Leaves. Under the shade of this Tree of Peace we spread the soft, feathery down of the globe thistle, there beneath the spreading branches of the Tree of Peace."

In the second "law" of the code, the four roots of the "tree" are described, and the law-giver says:

"If any individual or any nation outside of the Five Nations shall obey the laws of the Great Peace and make known their disposition to the lords of the confederacy, they may trace the roots of the tree, and if their minds are clean and obedient . . . they shall be welcome to take shelter beneath the Tree of the Long Leaves.

"We place in the top of the Tree of the Long Leaves an Eagle who is able to see afar; . . . he will warn the people."

In another place is the following:

"I, Dekanawide, and the union lords now uproot the tallest pine tree and into the cavity thereby made we cast all weapons of war. Into the depths of the earth, down into the deep underearth currents of water flowing to unknown regions we cast all the weapons of strife. We bury them from sight and we plant again the tree. Thus shall the Great Peace, Kaye narhe ko wa, be established."

These laws and figures of speech are evidently those which the Iroquois speakers had in mind when addressing "peace councils" with the whites.

Symbolic trees appear not only in Iroquois history, mythology, and folk beliefs, but also in their decorative art. The numerous decorative forms of trees embroidered in moose hair and porcupine quills by the eastern Algonquians, by the Hurons, and by the Iroquois appear to be attempts to represent the world-tree and the celestial tree, in some cases, with "all manner of fruits and flowers." Many, if not most, of the modern descendants of the old-time Indians, who copy these old designs, have forgotten their meanings, and some have even invented new explanations. A few of the more conservative, however, still remember the true meanings of their designs and from these much of interest has been learned.

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